

SECTION D, PART 0

TERMINATING CALL TROUBLE CARD ANALYSIS

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D0 TERMINATING CALL TROUBLE CARD ANALYSIS

The trouble analysis flow charts in the A2 Section of the SFD direct the reader to one of the rounded boxes† at the left of SFD-D002 for terminating call trouble record cards.

D0-1 CROSS DETECTION, SEQUENCE FAILURE (SFD-D002)

For either of the double sided trouble cards, there is an MXT designation which is punched if there is a cross detected (X--) or if there is a sequence failure (SQA) of the junctor walking circuit. For the single sided trouble card, there is no MXT punch and it is necessary to scan all the X-- designations and the SQA designation to determine if there is a cross or sequence failure. The reader should proceed through each decision box following Y (yes) if the designation is punched or the statement is true or N (no) if the designation is not punched or the statement is not true. If there is no MXT, cross or sequence failure, the procedure beyond that point is the same for all trouble record cards.

D0-2 TIMING FUNCTIONS

The DTM and CM are designed in such a way that they are timed from seizure until release. Critical functions are timed separately. Understanding the purpose and function of timing circuits will aid the crafts person in understanding the behavior of the marker. General functions of the OAT, WT, SDT/LDT, TRS and LR timers will be discussed in this section.

D0-2.1 OVERALL TIMER (OAT)

The OAT is started when the CM is seized and is stopped when the marker is restored to normal. The timing interval is 9.6 to 15.4 seconds which is greater than the time required on any normal marker usage. This timer guards against failure of any of the other timers. Operation of the timer causes the marker to release without a trouble record but will sound a major alarm.

† Symbols used in flowcharts are described on SFD-A103.

D0-2.2 WORK TIMER (WT)

The WT timer is started when the marker is seized and is stopped when the marker is restored to normal. The timing interval is 450 to 605 milliseconds. This short timer is used to detect troubles as soon as possible in order to quickly release the marker. The WT timer is re-cycled as the call progresses. Operation of the WT causes the marker to take a trouble record before releasing and will be the timer that will most often generate a trouble record.

D0-2.3 SHORT DELAY TIMER (SDT) AND LONG DELAY TIMER (LDT)

The SDT provides a delay of 2.6 to 4.5 seconds on service calls and 1.1 to 1.9 seconds on no-test calls. The LDT provides a delay of 4.6 to 7.5 seconds. Both timers are started by the operation of the seize frame (SF) and seize frame timer (SFT) relays. The operation of the SF stops the WT timer. The SF and SFT relays operate when the marker closes a start lead to select a frame such as the LL, TL, NG, OSC or FAT. The SF and SFT relays also operate on various test calls and on completion of the sender trunk guard test. The SDT timer always functions first unless the trouble recorder is busy. This condition requires the longer timing provided by the LDT. If the SDT should fail, the LDT, which is also timing will function as a back up.

D0-2.4 TRANSFER START TIMER (TRS)

The TRS circuit functions to transfer the marker connector start leads to the alternate marker preference whenever a marker is not seized in approximately one second. If the WT, SDT/LDT are not punched and the TRS is punched, the trouble record indicates that the marker connector could not connect to a CM within the transfer start timing interval and had to transfer its start leads.

D0-2.5 LINK RELEASE (LR) WITH OR WITHOUT DCK

Since the IRL (incoming register link) circuit contains no timing feature and since a link failure would block calls from numerous incoming trunks, the IR (incoming register) is arranged to time for completion of link functions and to cause a CM (completing marker) connection and release of the IR if they are not completed within 325 milliseconds nominal. Timing is accomplished with the LR (link release) tube, LR relay, and the associated capacitor-resistor network.

The LR relay function in the IR, grounds the LR lead to the CM, so that the CM can take appropriate action. If the DCK is operated, it indicates that a link crosspoint has been closed and that no double connection exists. If the DCK is not operated and the LR is operated, the IRL failed to pass information through its cross-connects to the IR.

D0-3 FALSE CROSS-GROUND TEST (FCG)

The FCG is the next punch designation which must be considered on the flow chart (SFD-D002) and will be discussed briefly at this time. During light traffic conditions the CM operates all hold magnets except the line hold magnet. The FCG relay is connected to the tip and ring leads and will operate if there is a cross between the tip and ring, a false ground on the ring conductor, or a false battery on the tip conductor. The FCG relay will lock operated, stop the marker progress, and force a WT time out.

D0-4 TROUBLE ANALYSIS SEQUENCE CHART (SFD-D003)

Standard sequence charts generally show a sequence of relay operation and release. All relays are shown that relate to a particular function. Trouble record punch indications are shown at the point in the sequence when ground is applied to or removed from the lead to the trouble recorder. Trouble analysis sequence charts omit relays shown on the regular sequence chart, except those relays associated with the trouble record designations (SFD-A103). A designation on the trouble analysis sequence chart without a punch symbol indicates the point in the sequence where that designation would be punched if a trouble record were taken. A designation with a triangle (base down) to its right indicates the point in the sequence after which a designation would not be punched.

D0-4.1 USE OF FLOW CHART AND TROUBLE ANALYSIS SEQUENCE CHART

This section will demonstrate the use of the flow chart (SFD-D002) and the trouble analysis sequence chart (SFD-D003). A crafts person experienced in the use of trouble record cards may find this section basic, but the procedures shown here (even though they may become automatic) are the procedures a qualified crafts person must perform.

Without a selection of trouble record cards to distribute to the reader, certain functions must be assumed. It is assumed that all trunks, trunk links, line links, incoming registers etc. vary. The only equipment that remains the same on all cards is the marker. Following the flow chart (SFD-D002) it is identified that the MXT punch is not indicated. The path to follow is marked N (No). The WT punch is indicated. The path to follow is marked Y (Yes). This procedure continues through the FCG N (No), the TK Y (Yes), the HMS1 Y (Yes), and the DCT1 N (No). The flow chart directs the reader to SFD-D003.

The trouble analysis sequence chart, and all sequence charts, operate from the top of the page to the bottom. To identify the trouble area the reader must start at that point of major failure and back-track to the point where all punch indications (leading to the branch in trouble) are shown.

To demonstrate: Working back from the DCT1, the DCT is indicated, the RCK3 is indicated, the RNG is not indicated. The chart directs the reader to coordinate K21 to continue back-tracking. The operated VTK1, HTK1, FTK1, FUT-, and FTT- indicate translation is complete.

The page coordinate P6 shows the portion of the trouble analysis sequence chart that is shown in detail on D402. Use of the sequence chart will be shown in paragraph SCD-D0-5.

D0-5 SEQUENCE CHARTS

The sequence charts used in the SFD follow standard conventions for sequence charts, except as noted on SFD-A103.

The example in D0-4.1 continues on SFD-D402. Most paths leading to the RNG relay (relay responsible for the DCT1 not operating) can be eliminated from information punched on the trouble record card. The CS-indication checks the VTK1, HTK1 and FTK1 relays have operated. The TK checks that the HGK, LFK, and other relays have operated. The HGK and LFK, in turn, check that the FTT- and FUT- have operated.

The remaining relays should be checked, which include the RCL-, RCT-, and LA relay. These will have to be visually checked since there are no punches for these relays. If they are operated, the operation of the HTK1 should be checked. The trouble record card shows the HTK1 punch but if the winding is open the punch would still be there. If all relays checked are operated, the path to operate the RNG relay should then be checked.

SECTION D, PART 1
INCOMING TRUNK SEIZURE, INCOMING
REGISTER SELECTION AND PULSING

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D ESTABLISHING AN INCOMING TRUNK CONNECTION

Incoming calls may be received from an operator or from a calling customer in a connecting office. The digital information is received by the IR (incoming register) which is connected to the CM (completing marker) through the IRMC (incoming register marker connector). The CM will determine from the information passed to it from the IR whether to process the incoming call as a terminating call, a toll or tandem through switched call, or a pulse conversion call.

A terminating call is one placed to a customer served within the marker group which requires a connection to be established between the trunk link appearance of the incoming trunk and the called customer's line appearance on the LL.

A route relay is not required on a TER call. Direct signals or translation determines that the call is to be completed locally and that FLG linkage is required.

The general sequence of operation of an incoming trunk connection is as follows:

The closure of the loop from the outgoing sender in the distant office to the incoming trunk causes the A relay to operate in the incoming trunk. This A relay closes battery to the IRL (incoming register link) and in response to this signal, the IRL functions to connect an idle IR to this trunk.

The IRL sends to the IR information consisting of class of trunk and trunk link frame number. This information will be used by the CM in processing the call. A crosspoint is closed in the IRL to connect the IR to the trunk. When this connection has been established, all checks satisfactorily completed, and a timed interval has passed, the IR takes control of the connection, reverses the tip and ring leads to signal the distant office that the IR is ready to receive pulses.

The IR may be of two types, DP (dial pulse) or MF (multifrequency). For DP, the signal is passed directly to the IR where it is stored to be passed to the CM. For MF, the signal (two frequencies) is received by a signal receiver, which converts the signal to direct current to be used by the office. These signals are also stored by the IR to be passed to the CM. After the IR receives all digits, it prepares the trunk to assume control of the connection. The IR then establishes a connection to the CM through the IRMC and passes information to the CM that is used to complete the call.

When a CM has been seized and has received input information through the IRMC, it proceeds to connect to the TL (trunk link) frame which contains the incoming trunk.

After the TL preference circuit operates, the CM connects to the incoming trunk. Trunk class information is passed from the trunk to the completing marker. The completing marker determines the location of the trunk on the TL and operates control relays and select magnets.

In a No. 5 crossbar office, there is no permanent or prearranged association of directory numbers with switch positions on the LL (line link) frames. A CM upon receiving the number for a terminating call must determine which of the many switch verticals in the office is associated with that particular directory or trunk number so that a connection may be established. The marker obtains this information from the NG (number group) frame. This frame is a large central memory kept up to date with the latest directory number assignments, to which each CM in turn applies for the necessary translation.

The LL containing the called line is seized to enable the CM control of the desired select and hold magnets. An LL seizure is also necessary whenever a connection to a called line location on a tandem type call is required. This connection is referred to as FLG (call forward linkage). The FLG is used on an INC TER (incoming terminating), TAN (tandem), and IAO (intraoffice) type calls.

Connections between a line and a trunk are made by closing the line switch and junctor switch crosspoints on the LL, and the junctor switch and trunk switch crosspoints on the TL. The select magnets and hold magnets involved in closing the specific crosspoints depend on the location of the line on the line switch, the trunk on the trunk switch, and on the channel selected.

Following hold magnet operation, the channel is checked for crosses, continuity, and double connections. The number group is released and the ringing switch crosspoints are operated. If all tests are satisfactory, the CM proceeds to disconnect and restores to normal.

D1 INCOMING REGISTER SELECTION AND PULSING

D1-1 TRUNK AND REGISTER PREFERENCE

The general overview of sheet D104 shows the TP- relay operation, selection and hold magnet operation in relation to the IRL and the incoming trunk. The association of TP00 to the AMRST (automatic monitor register sender test) circuit is also shown. The IRL basic and supplementary switches of the first, intermediate, and last horizontal groups are shown with their associated select and hold magnet leads.

The interconnecting leads ST, RB, BL, LK, and SM- are carried over to sheets D106 and D107 which show the incoming registers and their association with register preference between the different horizontal groups on the IRL frame.

Register preference shown on sheets D106 and D107 are layed out in block diagram style and alphabetized to indicate first, intermediate and last appearances in the horizontal group of the IRL frame. Block diagrams are shown of the different appearances of incoming registers 0 through 9. Refer to Notes 1 through 5 on sheet D107 for explanation and proper use of the multiple leads and preference blocks in relation to chain circuit leads and preference chains. The vertical blocks A through C are associated with the incoming register designated E at the bottom of each row. A combination of the same blocks in horizontal rows are associated with the horizontal groups. Therefore work chains and preference chains can be followed to the end.

On SFD-D105 a block diagram can be used to trace through the incoming register link chain circuits. The colors used are red for the ST lead chain, blue for the B (B, B1, and B2) lead preference chain, and green for various work chain leads (SFD-D105).

D1-2 OPERATION OF TRUNK PREFERENCE RELAYS (SFD-D104)

When an incoming trunk requires connection to a register it connects battery on the ST- lead to operate its TP- (trunk preference) relay as shown in D104.

Since all the TP- relays in a horizontal group are in a chain of preference, only one trunk can proceed at a time. The operation of a TP- relay such as the one shown for an intermediate trunk opens ground from the windings of all the higher numbered TP- relays. Lower numbered TP- relays may operate but can do no work since all of the work leads are in a chain running in the opposite direction and these are opened at higher numbered relays. If during the time one call is being served and other TP- relays operate, these trunks will be served in order starting from the highest numbered. Trunks which cannot operate their TP- relays must wait until the last operated TP- relay is released before being served.

D1-3 SELECTION OF IDLE REGISTERS (SFD-D106, D107)

The register control circuit consists of relays RP- and RB- which are furnished one per register per horizontal group. The RP- (register preference) relays carry a number of work leads in chains and the RB- (register busy) relays perform the function of controlling the start lead from the trunk preference relays.

A ground from the operated TP- relays (SFD-D104) is furnished to prepare the operation of the RP- relay of the first idle register in the chain of preference over the ST lead through the RB- relay contacts (SFD-D106).

On SFD-D106, note that the battery for operating the RP- relays is supplied by the associated incoming register over the B lead and then taken through a chain of contacts on the RP- relays associated with that register. To simplify this arrangement of multiplying between other registers on link switch levels an arbitrary lead designation has been shown. For example, B lead from block A splits into two leads designated B1 and B2 for easier reference of chain operation. Block A represents the start of the preference chain and end of the work chain. Block B is an intermediate representation of both chains, and Block C represents the start of the work chain and end of the preference chain.

D1-3.1 OPERATION OF REGISTER PREFERENCE

The operation of a RP- relay prepares a path for the operation of C-relay over TF lead from incoming register. Note here that the battery side of C relay has been given the arbitrary designation C lead as it multiplies between other horizontals and finally connects to the B or battery supply from the incoming register in Block A on sheet D106.

If the preferred register is idle, its register preference relay operates; but if it is busy, its register busy relay will be operated advancing the start lead to the succeeding register.

The operation of the RP- relay constitutes seizure of the register. The register preference relay operates an ON (off-normal) relay in the IR which prepares the register for operation. A RB (register busy) relay in the IR operates which causes operation of link register busy relays for this register in all other horizontal groups. Operation of the RB relay in the IR operates the RB- relays in the IRL on all horizontal groups except the one being served. The RB- relay in the selected horizontal group is held shunted down by ground on the LO lead until the RLK relay in the IR operates to allow the RB- relay associated with the IR in the IRL to operate.

D1-3.2 CLOSURE OF SWITCH CROSSPOINTS (SFD-D104)

Operation of the register off normal relay and an IRL select magnet closes a circuit through the operated trunk preference relay to operate the hold magnet for the trunk being served. This operating ground is extended through crosspoints to operate relay H which opens the circuit through the trunk preference relay and closes the circuit to the DCK (double connection check) relay. The DCK operates unless there is a

ground already on the crosspoints which would occur if two crosspoints were closed to the same register. The DCK would be shunted down and a marker would be called in for a trouble record. Otherwise, this DCK locks and the hold magnet is held over the HM lead through the crosspoints. The operated H relay releases the select magnet.

D1-3.3 REGISTRATION OF INCOMING TRUNK CLASS (SFD-D108)

The IRL sends to the IR information consisting of class of trunk, trunk link frame number and trunk location for translation to a trunk number (if a trunk number is required). This information sent to the IR will be used by the CM to establish a connection to the incoming trunk.

The RP- relay in the IRL operates associated relays designated C and CA from ground on the TF lead.

One out of eleven leads is grounded by an operated TP- relay to indicate the trunk class to the register. In all cases except for Phase I and II centrex transfer type trunks and 2 way operator office trunks the class indication is determined by a cross-connection from TPC- to CL00-10. The other end of the eleven leads CL00-10 are brought out to the register frame for cross-connection to six nonspecial and special class combinations. The designation of these cross-connection punches are as follows:

- OA - Where four digits calls are received for termination in office A.
- OB - Where four digits calls are received for termination in office B.
- AB - Where five digits calls are completed and the initial digit indicates the required office number.
- OAS - Same as OA for calls received on a special call basis (OPR and local test desk).
- OBS - Same as OB for calls received on a special call basis (OPR and local test desk).
- ABS - Same as AB for calls received on a special call basis (OPR and local test desk).

If the trunk class is one of the special combinations the CLS relay will operate and will in turn operate the CLT relay. The CLT relay then connects the OAS, OBS, or ABS leads to the corresponding OA, OB or AB relays to cause operation of the proper relay.

D1-3.4 REGISTRATION OF TRUNK LINK NUMBER (SFD-D109)

Similar to class registration, trunk link information is furnished by grounding one of 40 TPU- cross-connection punchings, which represent the location of the incoming trunk in the incoming register link. The TPU- to TFU- cross-connect is determined by the units digit of the trunk link frame on which the incoming trunk is located.

The FG- to G- cross-connection is determined by the horizontal group and FG (or tens digit) of TL frame number on which the incoming trunk is located. The FG0-2 leads are connected directly to the corresponding FG0 to FG2 relays to determine the proper horizontal group information in the incoming register.

One of the leads TF0 to TF9 in the incoming register will be grounded on each call, when the connecting relay of the IRI horizontal group associated with the selected incoming register operates. This TF- lead causes operation of one-out-of-five TF- relays in the IR. The one TF-2/5 relay, in operating, locks and operates the TFT (trunk frame transfer) relay which transfers the incoming TF lead from the one TF-2/5 relay to another TF-2/5 relay. The two TF2/5 relays connected to each lead have the numerical designation of the lead. For example, a ground on lead TF2 will initially cause operation of relay TF2. The TF2 will operate TFT which connects lead TF2 to relay TF0, operating the TF0 relay.

Each of the operated TF- relays will ground a correspondingly numbered lead to the marker connector. A contact of TFT is placed in the CK relay operating path to insure that TFT is operated. This insures that a ground has been received on one of the TF- leads. If a ground is not present on one of the TF0-9 leads, TFT will not operate and the LR (link release) timer will function to cause connection to a marker with a LR failure indication. If a trouble record is taken at this time, it will indicate the link groups involved in the call.

D1-4 REGISTER PULSING, MF

D1-4.1 PREPARATION FOR RECEIPT OF PULSES

The RLK operates at the completion of the link functions. It opens the discharge path of the RV timing circuit and closes a charging path from the RV relay to the RV capacitor to start timing. The RV relay operates after 190 milliseconds nominal time and locks to its secondary winding. The operation of relay RV reverses the polarity of the tip and ring leads to the outgoing trunk in the originating office. This signals the outgoing trunk or operator that pulsing should start. The register is ready to receive pulses at this time because relay ON1, which operated

from the ON, has connected battery on leads BAT1 and BAT2 to the signal receiver circuit. The digit register has been prepared for registration of digits by operation of the first steering relay AS from the ON relay.

D1-4.2 PULSING PATH DESCRIPTION (SFD-D110,D111)

The SFD-D110, D111 shows the complete pulsing path from the OSMF in the originating office to the IRMF in the terminating office. This path extends through OSL with an outgoing trunk attached, through the main distributing frame jumpers to cable conductors that connect to the distant terminating office, through the incoming trunk circuit which connects to the IRL and IR and finally to the end circuit MF receiver associated with the IR.

Each digit transmitted by multifrequency consists of a pulse of two-out-of-five audio frequencies. These frequencies are 700, 900, 1100, 1300, and 1500 cycles per second, designated 0, 1, 2, 4, and 7 respectively. In addition, a key pulse using frequency 1100 and 1700 cycles is transmitted as a gate opener. Also, a start pulse using frequencies 1500 and 1700 cycles is transmitted after the last digit as a start signal for the terminating IR to complete its function. The entire code digits used are as follows:

D1-4.2.1 MF Frequency Chart

<u>Digit</u>	<u>Designations</u>	<u>Actual Frequencies Cycles per Second</u>
0	4, 7	1300, 1500
1	0, 1	700, 900
2	0, 2	700, 1100
3	1, 2	900, 1100
4	0, 4	700, 1300
5	1, 4	900, 1300
6	2, 4	1100, 1300
7	0, 7	700, 1500
8	1, 7	900, 1500
9	2, 9	1100, 1500
KP	2, 10	1100, 1700
START	7, 10	1500, 1700

D1-4.3 MF RECEIVER CIRCUIT SD-95536-01 (SFD-D112)

The receiver circuit is maintained in a disable condition until it receives the key pulse (gate opener) so that it will not react to unwanted signals that may appear on the line due to inductive pick up. The KP signal is received entirely by the signal receiver without operating relays in the register. Each subsequent digit causes the receiver SP (signal present) tube and relay to operate. The SP relay in turn causes operation of receiver relay LK over the leads J and L, shown on SFD-D113. The LK relay connects +130 volt battery to the receiver channel relays and when the channel thyratron tubes (corresponding to the frequencies received) operate causes associated receiver channel relays to operate. The operation of two channel relays ground the corresponding leads 0, 1, 2, 4, or 7 causing operation of the corresponding A2/5-L2/5 digit register relays and also operates the RA relay over the S lead, shown on sheet SFD-D112 and D113. The operating path of the receiver channel relays includes the winding of the receiver relay CK2 which operates and causes operation of register relay 2CK over lead H.

Operation of RA operates the next digit steering relay and with 2CK operated opens the J and L leads to the receiver which releases relay LK. The release of LK releases the channel relays and relay CK2. If by this time the signal is ended, relays 2CK and RA release and allow release of the steering relay for the digit just received. If, however, the signal pulse is still present, relays RA and 2CK will be locked to the receiver signal present relay SP over lead J. These interlocking features are provided to insure that each pulse locks in until it has been recorded and that the register does not advance to the next digit until the end of pulse.

D1-4.4 DIGIT REGISTRATION (SFD-D113)

The digit register unit consists of a dry reed relay pack with five independent coils inclosed in a can and with each coil associated with two make contacts. One terminal of each of the coils is wired internally to one of its associated contacts for locking purpose and a single lead is wired to a terminal. One contact of the locking contact pair, one terminal of the coil and both contacts of the load contact pair are wired to individual terminals. These terminals extend to both front and back of the dry reed relay pack for ease of wiring and testing. Also for ease of wiring, three sets of terminals are strapped internally. These terminals are the battery side of the coils, the locking contact of the relays, and one side of the load contacts.

D1-4.5 DIGIT STEERING CIRCUIT (SFD-D113)

The digit steering circuit consists of a single relay per digit AS-LS. Each steering relay is advance by a contact on the RA (register advance) relay. At the time of seizure, the register relay ON operates in turn operating the AS which locks through series back (break) contacts of all

the steering relays. The RLK opens the operating circuit of AS. On the first operation of RA, the BS relay operates through contacts of AS. The BS locks through a back contact of CS and opens its operating circuit on one set of continuity transfer contacts. The BS, on another set of continuity transfer contacts, transfers the locking circuit of AS from the off-normal ground to the RA controlled ground so that when RA releases AS will release. The next operation of RA will operate CS through back contacts of AS and front contacts of BS and the next release of RA will release BS. This action continues with each operation of RA operating the steering relay for the next digit and each release of RA releasing the steering for the digit just registered.

D1-4.6 REGISTRATION OF THE A DIGIT (SFD-D113)

The AS (A digit steering) relay is operated from the ON relay when the register is seized. When the A digit frequencies enter the receiver, the MF receiver SP (signal present) tube and relay operate. The SP connects ground on lead J which is connected through back contacts on relays MST, TEN, STS (and depending on the number of digit registers equipped), BS, DS, FS, HS, and KS to lead "L" to the winding of receiver relay LK. The steering relay part of this path is paralleled by a circuit through a back contact of 2CK. The LK operates and connects battery to the receiver channel relays and when the channel thyatron tubes (corresponding to the frequencies received) operate cause associated channel relays to connect ground to corresponding leads to the register. These grounds are carried through the contacts of AS relay to operate the corresponding A digit register relays which lock.

When the receiving circuit detects one or more frequencies, the corresponding numerically designated relays of the receiving circuit operate and cause operation of RA over lead S. When the receiver circuit detects two frequencies and two of the numerically designated relays operate, the receiver CK2 relay operates causing operation of the 2CK relay. Both RA and 2CK lock to the J lead which is controlled by the SP and the CK2 relays of the receiver. The RA operates BS which opens one leg of the circuit between the J and L leads in the register and when 2CK operates the J lead is disconnected from the L lead allowing release of the LK relay of the receiver. The LK, in turn, releases the receiver CK2 and numerically designated relays. If the signal pulse has ended or when it ends, SP will release. With both SP and CK2 released, RA and 2CK will release. The RA, in releasing, completes the steering advance by causing release of AS which recloses one leg of the circuit between the J and L leads. The release of 2CK relay recloses the other leg of the circuit between the J and L leads. Either leg being closed enables the relays of the receiver to respond to the next digit signal.

D1-4.7 REGISTRATION OF THE B DIGIT

The B digit is recorded in the same manner described for the A digit. When the frequencies are detected, the receiver SP relay operates. The LK relay operates to enable the receiver channel relays. Two of the

channel receiver relays operating will cause operation of CK2. Register relays RA and 2CK operate the steering relay CS to open the J and L leads to relay LK which, in turn, releases the receiver channel relays and CK2. The B digit register relays operate from the receiver channel relays. Subsequent digits are received and recorded in a similar manner.

D1-4.8 PULSE CONSISTING OF MORE THAN TWO FREQUENCIES (SFD-D112)

If a trouble condition exists that causes more than two receiver channel relays to operate, the current drawn by the receiver channel relays will exceed the minimum required to operate the receiver relay CK3. Operation of CK3 grounds lead RO which operates the RO (reorder) relay. The RO relay causes the marker to be seized with a reorder indication.

D1-5 REGISTER PULSING, DP

D1-5.1 GENERAL DESCRIPTION

The dial pulse incoming register is used to receive information in the form of dial pulses over a trunk from another office and when the entire number is received to transfer this information to the marker so that a connection can be set up between the incoming trunk and the called line.

D1-5.2 TYPES OF TRUNKS

The register is arranged to receive pulsing from two different types of trunks. By-link pulsing trunks are those originating principally in SXS offices on which pulsing may start soon after the trunk is seized. For these trunks an early or by-link pulsing path is established through the control relays of the IRL to carry the pulsing signals until the IRL switch contacts close the regular path. Direct pulsing trunks are those on which pulsing will not start until a signal, either dial tone or a trunk reversal, is returned by the register. When a direct pulsing trunk is connected to the register a relay is operated in the trunk which gives the register sole access to the tip and ring from the calling office and it receives pulses directly from that source. All trunks on a particular IRL switch must be of the same type in respect to the type of pulsing.

D1-5.3 LINK CONTROL

In cooperation with the IRL circuit the register establishes a connection from the trunk to the register through the IRL switch contacts, checking that there is no double connection. The register prepares to receive pulses and distinguishes whether the connection is to a by-link or direct pulsing trunk. After all required information has been received the IRL control relays are released. If a direct pulsing trunk

is connected to the register, the battery and ground supplied by the register to the tip and ring of the trunk are reversed after a time interval and dial tone is connected when required by the trunk circuit as a start pulsing signal.

D1-5.4 DIGIT COUNTING AND REGISTRATION

The register then counts the number of pulses in each digit and when the dialing is completed transfers this count to the digit register and recycles to make itself ready for reception of the next digit. By recognizing the start and completion of each digit it controls the progress of the register steering circuit. A digit register unit with five elements is provided for each digit, better known as reed type storing relays. These relays operate on two-out-of-five basis. A steering circuit which is controlled by a RAL (register advance relay) progressively associates the register units with the counting circuit as digits are received. The steering circuit consists of one relay for each group of register relays (AS, BS, CS, etc.).

D1-5.5 TRUNK CLASS

When all digits have been received the register operates the MST (marker start) relay to start seizure of a marker. The steering relays are used to indicate when particular digits have been registered. As these relays operate they ground the C to L terminals with the terminal designation corresponding to a digit being grounded following registration of that digit. For example, when the D digit is registered, the ES relay is operated to ground O terminal. These terminals with their cross connections, and in some cases permanent wiring to contacts of the class relays (OA, OB, and AB) are used to operate the MST (marker start) relay. Since the register does not receive the same number of digits from all incoming trunks, the operation of MST is controlled either directly or indirectly by the class relays. For instance, for a four digit local completing incoming trunk with the OA class relay operated, the MST will be operated when ES operates after the fourth digit is registered. For a five digit local completing incoming trunk with the AB class relay operated, the MST will be operated when FS operates after the fifth digit is registered.

The MST terminal is connected directly to the MST relay winding and a ground at this terminal will cause selection of the marker without delay.

D1-5.6 ABANDONED CALL TIMING - DIRECT PULSING TRUNK

The abandoned call timing in the dial pulse register is accomplished with the AC cold cathode tube, AC relay, and the associated AC resistors and timing capacitor. The AC capacitor is discharged between calls through normal contacts of the BL and CK relays and the operation of CK opens this path.

After the line reversal start dialing signal is transmitted, the L relay is under control of the calling office and L relay controls the ACC relay. During the dialing of each digit, the L relay will release to open the circuit to ACC. The ACC may or may not release depending on the length of the open pulse but if it does release it will reoperate on the next closure. The time of the timer is such that it will not operate on the longest dial open but will operate if L and ACC remain normal somewhat longer than the time of the longest dial open indicating that the call has been abandoned.

After all the digits have been registered, the L and ACC relays will release but TC1 will operate to prevent the timer from functioning. If the call is abandoned after TC1 operates, the release of TC1 will cause operation of the timer. If the discharge shunt around the AC capacitor is removed for a nominal time of 190 milliseconds the tube ionizes and AC operates. The AC relay operates the MRL to cause release of the register.

D1-6 REGISTER AND LINK TIMING (SFD-D114)

D1-6.1 TIMING DESCRIPTION

Since the IRL circuit contains no timing feature and since a link failure would block calls from numerous incoming trunks, the register is arranged to time for completion of link functions and to cause a marker connection and release of the register if they are not completed within a nominal timing period.

When the register is seized, two trouble condition timers are started. These are the LR (link release) and the TM (overall timer). The LR timer will detect a trouble condition which prevents the IRL from completing its functions and indicate this to the CM so that appropriate action can be taken.

The RLK relay, when operated, cancels the LR timer. The two key relays that must be operated to satisfy RLK operation are the CK and DCK. The CK relay operates if all class information is received properly from IRL and DCK will operate if no problems are encountered with IRL switch linkage.

The overall timing in the register is accomplished by the TM relay, TM tube, and the associated resistor-capacitor network. A period of 25 seconds nominal is allowed for all digits to be recorded. If MST (marker start) relay does not operate within the interval (after register seizure) the register will time out and call in a marker for a reorder connection. Once MST has operated, a second period of 25 seconds nominal is allowed for completion of the marker functions and register release.

If the register does not release within this interval, an abandoned call is simulated in an attempt to release the register. In case the register fails to release, the office alarm is operated.

D1-7 SELECTION OF REGISTER BY AMRST (SFD-D116, D117)

D1-7.1 MONITOR PREPARATION

Before the AMRST (automatic monitor, register and sender test) is connected to the register to be tested, it is necessary to prepare the AMRST (monitor) for testing. The Incoming Register key (IR) should be operated, followed by the operation of the STT key. This operates the STT relay which serves as a general off-normal relay for testing operation of the monitor. The number to be pulsed is set up on keys or switches on the MTC (master test control) circuit. The particular test and pulsing conditions are also set up on the keys or switches as necessary.

The number of the register in its incoming register link group is set up by setting the corresponding numbers on the SRS switch or SRS key. The number of the incoming register group is then set up by setting the IG-switch or operating a IG- key to the position numbered to correspond with the number of the incoming register group in which the register to be tested is located. Ground from STT relay contacts through the IG-switch or IG- key operates the MIR1 relay for multifrequency group. The MIR1 relay operation creates a path for operating all the SPR- relays. The SPR- relays open the paths by which the IRP- relays are operated from the incoming links. The PC- relay operates through the SPR- relay selected by the IG switch or by an IG- key. The PC- relay connects the windings of the 10 IRP- relays of its incoming register group to positions 0-9 on the SRS switch or to the 10 units on the SRS key.

If MIR1 operates, it operates MR and MF to prepare those circuits for multifrequency operation. The MIR1 also operates BT1 relay which connects battery to the N lead to the MTC circuit to make the start key of that circuit effective. When the start key is operated, it connects ground to operate the BT2 relay through the MIR1 relay. The operation of BT2 relay operates the IRP- relay associated with the register selected by connecting operating battery and ground for the IRP- relays through the operated PC- relays and SRS switch or key to ground. The BT2 relay also opens the operating path of BT1 relay.

D1-7.2 PARTICULAR REGISTER SELECTION

The IRP- relay, operating, will prepare the path for the operation of the M relay in that particular selected incoming register. The purpose of the M relay is to connect the incoming register to the test frame for

monitoring or testing. If a call is in progress, the ground which holds ON relay operated will also hold the BT1 relay operated. When the register becomes idle, BT1 releases and closes ground to the IRP- relay contact associated with the last register.

For MF registers, MIR2 will operate through contacts of MIR1. The MIR2 relay serves as a cut-in relay for the leads from register to monitor previously closed at the register end by the M relay.

The relay BT1 is slow-release to extend the operate time of IRP- and M and also to permit the register to fully release before it is resealed. With the register now idle but held busy to service calls, MIR2 operates the IRST (incoming register start) relay to start selection of the register through the incoming register link circuit. When the register has been found to be idle, the IRST operates. The IRST relay supplies several off-normal grounds, one which lights the RB progress lamp, one which closes a circuit from battery through resistor ST, through a front contact of relay IRST, through back contacts of C, LKT, and BL1, through a front contact of an operated PC- relay to ST lead to the IRL and, through the winding of TP00 (trunk preference) relay to ground. The complete operating path of TP- relay is found on SFD-D104.

D1-7.2.1 Selection with Incoming Register Link

Operation of relay TP00 in the IRL locks out all trunks in horizontal group 0 which have not already operated their preference relays. The test circuit must wait until all trunks which have preference relays operated have been served. When all preference relays of horizontal group 0 are normal except the test preference relay, the IRL grounds lead B, operating the associated trunk class relay TCL- (SFD-D117). This relay operates the associated lock-out relays and operate register preference relays LO- and ORP-.

The LO- relay closes a register busy lead RB from ground through the primary winding of the RB1 relay to the register under test on a circuit through a back contact of RB2, back contact of C, front contact of IRST, through the SRS selector switch or key, front contact of LO-, the RB lead to the IRL, and the RB0 lead from the IRL link to the register. Since the register has been made busy by the test circuit, the register should have 226 ohm battery connected to lead RB, which will operate relay RB1. The RB1 relay locks operated on its secondary winding.

The RB1 relay operates relay RB2, which operates the preference relay in the IRL by connecting ground from a back contact of C relay, through a front contact of RB2, through the selector switch SRS or an operated key unit of the SRS key, through a front contact of relay ORP- to the RP lead in the link. The RB2 relay also changes progress lamps, lighting LO, and transfers the RB lead to the winding of relay RB3. The IRL RP-relay connects the RB lead to LO to the register, where there should be

solid ground. The RB3 relay tests for this ground. If the ground is missing, the RB lead will be connected in the link and register to 100 ohm ground and 226 ohm battery. Since relay RB3 is supplied with 200 ohm battery and 100 ohm ground, it will operate if direct ground is connected to the register L0 lead, but will not operate otherwise because it will then be in a balanced bridge circuit.

D1-7.3 PROGRESS LAMPS (SFD-D116)

When the RB3 relay operates, it locks operated, transfers the progress indications from lamp L0 to lamp LK, and connects lead LK from the IRL to the winding of relay LK (SFD-D104). The register has resistance battery connected to lead LK, which will operate relay LK. This places the IRL connection under control of the register by connecting the LK lead to lead ST. The LK relay, in operating, transfers the progress indication from LK lamp to OH lamp and connects lead OH from the IRL to the winding of relay OH (SFD-D104). The register should operate its IRL select magnets and ground lead OH to the IRL. The select magnet off-normal contacts should close the OH lead through to the test circuit, operating relay OH. The OH relay locks operated and transfers lead OH from its winding to lead HM to the IRL, operating the test circuit hold magnet in the IRL.

The OH relay transfers the progress indication from lamp OH to lamp CO and closes an operating circuit for the C relay. The C relay locks operated, extinguishes the CO progress lamp, and connects D lead from the IRL to the winding of D relay. The subsequent operations depend on whether the test is bylink, dial pulse, or multifrequency.

D1-8 STANDING CROSS RELAY TROUBLE INDICATION (SFD-D115)

For either of the double sided trouble cards (1/X type CD-25805-01 or 2/5 type CD-27718-01), there is a MXT designation which is punched if there is a cross detected (X-) or if there is a sequence failure (SQA) of the junctor walking circuit. For the single sided trouble card (1/X type CD25805-01), there is no MXT punch and therefore it is necessary to scan all the X-designations and the SQA designation to determine if there is a cross of sequence failure.

After the particular cross relay operates, its contact sends a ground toward the master test frame connector circuit for trouble indication display through the trouble recorder circuit.

D1-9 MASTER TRAFFIC CONTROL

D1-9.1 GENERAL DESCRIPTION OF OPERATION

The master traffic control and frame control circuits govern the traffic between connectors and markers during periods of heavy load or, more particularly, whenever requests for markers overlap. When several connectors with several calls each are requesting markers, the most equitable service is given by serving one call out of each waiting connector before serving a second call from any connector. By this means, the connectors with slow-start circuits are not blocked by connectors with faster-start circuits and one connector with several calls backed up cannot block other connectors for an unduly long time.

This process of locking out connectors once served is called "gating" which is the major function of the master traffic control, frame control, and connector control circuits. When a connector is prevented by its control circuit from obtaining a marker, the connector is said to be "gated", and conversely, when it is free to obtain a marker it is said to be "ungated."

The TC and TC1 relays in the connector control circuit, controlling marker start STA and STB leads, determines the gating. When these relays are operated, the connector is prevented from obtaining a marker, and when they are released, the connector can seize a marker.

With dial tone marker operation a short-cycle gate traffic control is used with line link marker connectors and a long-cycle gate traffic control is used with originating and incoming register marker connectors.

Duplicate tube timing circuits are provided and their function is to ungate the connectors in case of trouble and to give a major alarm. One of these circuits is associated with the STA lead and one with the STB lead. The ALA and ALB relays which are operated by the timers are held under control of the MC-AR key in the master test frame. The circuits for ungating the connectors are also under control of keys on the master test frame.

D1-9.2 CONTROL OF TRAFFIC THROUGH INCOMING REGISTER MARKER CONNECTORS (SFD-D132, D133, AND D134)

D1-9.2.1 Circuit Normal (SFD-D134)

When all associated connectors are idle, relays TCA1 and TCBA1 in master traffic control circuit are operated and all other relays are nonoperated. The two timing circuits are prevented from functioning by TCA1 and TCBA1. Any trouble which would cause relays TMA, TMB, CWA or CWB to operate when the connectors are not in use, will bring in a major alarm.

D1-9.2.2 Single Request for a Marker - No Gating (SFD-D134)

A single connection to a marker which is completed and released before a second request is initiated does not involve gating. In the connector, the control circuit will shift its start lead preference after its use so that a succeeding call will prefer a different marker.

The TM relay in the preference control circuit, operating in response to a request for a marker by an incoming register closes ground to the TCA and TCB leads, and either the CWA or CWB lead (SFD-D134). The CWA or CWB lead is determined by connector control Z relay which also determines whether the STA or STB lead will be used. When Z is normal, the STA and CWA leads are closed, and when Z is operated the STB and CWB leads are closed. The TM also connects the IM relay in the preference control circuit to the IM lead.

If a call is waiting to be served, the TCA and TCB relays operate and then lock to the TCA and TCB leads. The SRA and SRB relays operate and open the TCA and TCB operating path. When the TCA and TCB relays operate, the TCA1 and TCB1 relays release.

With the Z relay normal, CWA is operated. Therefore TMA timer starts to time and the TMB timer is stopped by battery being closed to the control anode through TCB1 contacts. The TMA and TMB relays will be normal if markers are available. The IM relay in the master traffic control circuit also operates and applies ground on IM lead to the preference control circuit, with relay TM operated. The IM relay in the preference control circuit operates and permits transfer timing in that circuit to start (SFD-D210).

The connector multicontact relays operate as a result of STA lead closure to the marker preference relay. The TC and TC1 relays in the preference control operate and open the circuit for the TCA and TCB relays. The TCA and TCB relays release and prevent the operation of the frame control relays FC and FC1. The CWA also releases and TCA1 and TCB1 relays operate to stop timing in the master traffic control circuit. The IM relay in the master traffic control releases to stop the transfer timing in the preference control circuit. The SRA and SRB relays release and the circuit is normal.

If relay Z had been operated, then CWB relay would have been operated on marker request. The TMB timer would have started timing and the TMB timer would have been stopped. Also, start lead STB would have been used on marker seizure.

D1-9.2.3 Overlapping Requests for Marker - Gating

If other requests are being made for markers, other connector control circuit TM relays will be operated and the TCA and TCB relays will remain locked. Since some connectors will be using the STA and some the STB leads, both relays CWA and CWB will be operated and both timers will be timing. As the available completing markers are seized by the connectors, the TC and TC1 relays are operated in those connectors and open their start leads. If other request for markers are being made, the timers will continue timing due to relays CWA and CWB remaining operated and relays TCA and TCB will remain locked. With the TCA and TCB relays operated, frame control relays FC and FC1 operate in all connector frames having any one pair of TC and TC1 relays operated, in turn locking all TC and TC1 relays in those frames. Those connectors are gated, that is, they are prevented from obtaining a marker, since their marker start leads are opened by the TC and TC1 relays. They will remain gated until the TCA and TCB relays release.

The SRA and SRB relays are released. These relays are slow to release to prevent reclosing the TCA and TCB lead until all FC, FC1, TC, TC1 relays are released, since another request during this ungating period could prevent proper release. This interval also allows the last marker connected to finish its work and release in order to prevent gating that connector for another gating cycle.

If the all-markers-busy condition is encountered during the gating cycle, the TMA and TMB relays will operate from the all-markers-busy circuit. The IM relay will release which in turn will release the IM relays in any preference control preventing them from making an ineffectual transfer of the start circuit.

SECTION D, PART 2
COMPLETING MARKER SEIZURE

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D2 COMPLETING MARKER SEIZURE

After the IR receives all digits and the incoming trunk has been prepared to assume control of the connection, the IR establishes a connection to the CM through the IRMC and passes information to the CM that is used to complete the call.

D2-1 SEIZURE AND INPUT TO COMPLETING MARKER

Upon operation of a TC2 relay in the incoming register and RB relay in the IRMC (SFD-D204), start battery is applied to activate a marker start STA lead or a marker start STB lead to start seizure of a completing marker. As will be seen later, the Z relay is operated and released on alternate calls so that the STA and STB start leads are alternately activated on successive calls. Each register is given preference to one completing marker for an MSA start and to another for an MSB start by cross-connecting MSA and MSB punchings on SFD-D204 to appropriate MS-punchings on SFD-D205.

D2-1.1 MARKER CONNECTOR RELAY CHAIN CIRCUITS (SFD-D205)

Three chain circuits are used in selecting a completing marker and closing the connector relays between the register and the marker selected. The following are typical descriptions of chains also used in other connectors.

D2-1.2 CB- (MARKER CONNECTOR BUSY) RELAY CHAIN

An operated CB- relay indicates that the associated marker is busy to the connector. A CB- relay operated for a preferred marker advances the start lead to the next preferred marker. If the CB- relay for that marker is also operated, the start lead is advanced to the next preferred marker, etc.

D2-1.3 MS- (MARKER START OR PREFERENCE) RELAY OPERATE CHAIN

In periods of very light traffic (and assuming no markers busy) MS-relay operation is straightforward. A start signal from an incoming register operates the MS- relay associated with the MS- terminal to which the start lead is cross-connected.

In periods of heavy traffic one or more markers may be busy and two or more incoming registers may initiate marker requests either simultaneously or in rapid succession.

Assume that the first and last incoming registers (SFD-D204, D205) initiate simultaneous marker requests. Also assume that both start

leads are connected to MSO (that is both prefer marker 0). The MSO relay associated with each of the two registers will operate through the MSK cross-connection to ground in the marker. An early make contact on the MSO relay for the first register will provide locking ground for that MSO relay before the break contact on the MSO relay for the last register opens the MSK ground. Thus, both relays will operate and lock.

If, however, the last register initiated a request for a marker slightly ahead of the first register, the MSO relay for the first register could not operate. On the other hand, if the first register initiated a marker request first, a subsequent request by the last register could operate the MSO relay for that frame.

D2-1.4 MS- RELAY WORK CHAIN

Since it is possible to operate two or more MS- relays at the same time, the work chain determines which MS- relay does the work. Ground for the work chain initiates in the marker at the MAK cross-connection. It should be noted that the work chain proceeds through contacts of each MSO relay in a reverse direction to the preference MSK chain. Contacts on the MSO relay for the first incoming register are, therefore, enabled to operate connector relays MA- through ME- whether or not any other MSO relay is operated.

Upon operation of the incoming register marker connector relays (MA- through ME-), the MCB- relays of the selected marker are operated over the MB lead (SFD-D206). The MCB- relays operate CBO relays in every connector having access to that marker (SFD-D205). It should be noted that an operated MA- connector relay contact bridges the break contact of the CBO relay in the start path so that the operated MSO relay is not released when the associated CBO relay operates.

If two or more MSO relays had operated for different incoming registers, the start lead for each of those which failed to get a marker would be advanced to the next preferred marker by operated CBO relays. If, however, no other marker was available no new MS- relay would operate until some marker became available at which time one or more MS- relays for that marker would operate. This would continue until all registers had been served.

During periods of heavy traffic when all completing markers become busy, a traffic control circuit gates requests by incoming registers for CMs as described in the SFD-D1 section so that all registers requesting service are served once before any register is served a second time.

Relay MS- in operating releases the marker connector check relays MAK, MCK, and MSK (SFD-D205). The release of any one of these relays operates relay TM (SFD-D206) which starts marker timing.

D2-1.5 W AND Z RELAY CONTROL FOR TRANSFERRING START LEADS (SFD-D204)

If only one start lead was provided, then, under light traffic conditions, a particular connector might seize the same marker for every usage. If this marker is in trouble, all calls from that register might be blocked. To prevent this and also to reduce the adverse effects of other circuit failures, two start leads are provided in each marker connector. By alternating the use of these start leads, two markers serve alternately as first choice markers, thereby providing more even wear on the marker connectors. This transfer is accomplished with a W and Z relay combination. The operation and release of relay MK provides the necessary transfer.

In the following description, assume that relay TRS (transfer start) is normal. The W and Z relay combination (SFD-D204) operates as follows:

(a) FIRST CONNECTOR USAGE

Marker seizure - Assume that relays MA- through ME- of the incoming register marker connector and W and Z of the preference control circuit are normal. Lead STA has continuity through the break contact of relay Z and lead STB is open. A marker is seized by operation of relay MS- via the MSA to MS cross-connection. Relay MS- causes the operation of relays MA- through ME-. Relay MA- operates relay MK in the preference control circuit (SFD-D204), which in turn operates relay W which locks.

Connector release - When the connector releases, release of the MA- relay releases relay MK which causes the Z relay to operate through the operated W. Relay Z locks operated from the ground of relay W which remains operated but the locking ground for W is now through the operated Z of the released MK. The operation of relay Z opens start lead STA and closes STB making it available for future usage.

(b) SECOND CONNECTOR USAGE

Marker seizure - At this time relays MA- through ME- are normal. Relays W and Z are operated. A marker is seized by the operation of relay MS- via the MSB to the MS- cross-connection. Relay MS- causes relays MA- through ME- to operate. The operation of relay MK, this time, opens the locking path of the W allowing it to release.

Connector release - The release of relay MK when the connector releases removes the Z relay holding ground, allowing it to release. Relay W remains released. The release of relay Z opens lead STB and closes lead STA making it available for the next connector usage. For subsequent usages the actions described above repeat.

D2-2 TIMING FUNCTIONS IN THE PREFERENCE CONTROL CIRCUIT

Timing circuits in the preference control circuit, control marker seizure and once the marker is seized, time its overall function. These timing circuits are discussed below.

D2-2.1 TRANSFER START TIMER (SFD-D210)

The transfer start timer allows an interval of 0.6 to 1.25 seconds for the IRMC to connect to a CM (unless all CMs are busy). If the connection is not established in this time, the preference control circuit transfers the start leads and gives a TRS signal to the CM to cause a trouble record to be taken showing that there is a transfer start condition.

The operation of the TC2 relay in the IR operates the TM relay (SFD-D210). The TM relay operates the TM1 and also closes through the IM lead from the master traffic control to operate the IM relay. The IM lead will normally be grounded unless all CMs are busy, in which case operation of the IM relay is delayed until a CM becomes idle. The IM relay starts the TRS timer.

The TRS timer continues to time until the connector relays MA- through ME- operate. To check that the connector relays have operated, the MA-relay connects ground to the CKG lead to operate CKG1,2 relays. The CKG2 relay connects ground to the MTFC as a check that the connector relays operate. The MC- relay grounds the TC and TC1 leads to operate the TC and TC1 relays in the preference control circuit. The operated TC and TC1 relays in the PC opens the path to the IM relay (SFD-D210) which stops and recycles the TRS timer.

If a marker is not seized in approximately one second, (providing markers are available as indicated by ground on the IM lead), the TRS tube will fire and operate the TRS relay. The TRS relay opens the start lead in use, closes the alternate one (SFD-D204), releases the TM relay in the preference control, and holds the TM1 relay operated (SFD-D210). The TM relay is released to open the signal leads CWA and TCA (SFD-D210) to the traffic control circuit to prevent its timing out because of a marker connector trouble. The TM relay also releases the IM relay to recycle the timer (SFD-D210). The TM1 relay is held operated to continue the overall timing before a marker is seized. The TRS relay locks operated through the TM1 relay. When a marker is obtained over the new start lead, the TM1 relay releases upon operation of the MK relay. The TRS relay remains operated over its locking contacts under control of the MK relay. The TRS relay transmits to the marker the fact that the transfer has taken place. This information is passed over the TRS lead. The marker causes a trouble record to be taken showing a TRS punch and indicating the IR which encountered the TRS failure. Upon release of the marker, the MK relay, in releasing, will release the TRS relay.

D2-2.2 OVERALL TIMER (SFD-D207)

An overall timing circuit is provided which sounds the major alarm if an IR calling for a marker has not been connected to one within 4.8 to 10 seconds. It functions as follows: Upon the start of a call, operation of a TC2 relay operates the TM relay in the Preference Control circuit (SFD-D210) concurrently with battery connection to the start leads for marker seizure. The TM relay operates the TMI relay which starts the overall TM timer (SFD-D207).

For normal operation, a marker is seized before the timing interval has elapsed. This is indicated by the operation of the MK relay (SFD-D207) from the operated marker multicontact connector relays in the incoming register marker connector circuit. The MK relay releases the TM and TMI relays. During the releasing time of the TM and TMI relays, the TM tube timer circuit is recycled by discharging the A capacitor through the C resistance. The TMI relay normal with the MK relay operated restarts the A capacitor charging circuit to time the release by the marker. If the marker releases the connector within the timing interval, the TM tube will not fire. However, should the marker exceed this time because of some trouble condition or should the marker connector relays remain operated due to a trouble, the TM tube will fire, operating the CA relay which brings in the major alarm and causes the IRMC- lamp at the JLK to remain lighted. This lamp normally flashes on each time the MK relay operates as an in-use indication for the IRMC. When it remains steadily lighted, it serves as an IRMC alarm indication.

The MK relay releases at the end of the call upon release of the incoming register marker connector circuit multicontact relays, and discharges the A capacitor to recycle the TM timer for the next call.

D2-3 INFORMATION FROM THE IRMC TO THE CM

When the IRMC is operated, it closes through a large group of leads between the register and the marker in order that the register can transmit many pieces of information at the same time. The information transmitted through the IRMC is shown in Table A on the following page.

TABLE A

Information transmitted through the incoming register marker connector is:

A 2/5 - L 2/5, M7	Called Number
LT, FVD	Translator to be used for translating office codes.
OA, OB	Local completion codes, office codes not received with called number. No translation required.
INC	Type of call for incoming trunk calls.
TFU 2/5, FG0-2	Trunk link frame.
TRK, TR2, TRS	First and second trial, and start lead transfer signals.
RO, LR, DCK	Trouble and check signals from the register.
CKG, TM, MB	Marker seizure from the register.
MRL, BT, TRL	Release signals to register for normal, busy, and trouble release.
ECN, OCN	Even or odd register marker connector.

D2-3.1 CALLED NUMBER INPUT FROM THE IRMC TO THE CM, AC2/5 - CC2/5, D2/5 - L2/5, M7 (SFD-D212)

The called number may contain from 1-11 digits, A-L. Each digit is received on a two-out-of-five code basis. There are various numbering plans that can be used, but in general the numbers consist of the following:

- (a) 4 numerical digits.
- (b) 1, 2, or 3 digit office code, plus 4 numerical digits.
- (c) A 3 digit area code, 3 digit office code and 4 numerical digits.

The SCD will discuss (a) and (b).

D2-3.2 TYPES OF TRANSLATORS

The marker provides several types of translators to handle the various offices. The type of translator to be used is always indicated to the CM by the register. The various translator indications are:

- (a) Local translator
- (b) Toll translator
- (c) FVD translator
- (d) No translator (OA, OB)

In this section of the SCD the local translation, the five digit translation and the OA and OB (no translation) will be discussed.

D2-3.2.1 LT, Local Translator

This indication requests the CM to use the translator provided for the three digit local office code. This translator is useful on incoming calls when the C digit conflicts with C digits of other office codes in the same marker group.

D2-3.2.2 FVD, Five Digit, Translator

The FVD (five digit) translator is used for an incoming type trunk when translation of only the A digit is required to indicate the office code.

When a call in a connecting office is routed to an office that has more than two office subdivisions (office codes), it may be connected to an incoming trunk that has a FVD incoming class. The sender in the connecting office receives a delete 2 indication (with a seven digit call) from its CM. The sender will output pulse starting with the C digit. The C digit received by the incoming register will be stored in the A reed pack of the incoming register, the D digit from the sender in the B reed pack, etc.

The IR will pass information to the CM on the A 2/5 - E2/5 leads (SFD-D212). Grounds on the A 2/5 - C 2/5 leads will operate the AC 2/5 - CC 2/5 relays. The AC 2/5 relays with the FVD and INC relays operated will operate a local translation, LPA/LPB, etc., relay depending on the office cross-connects (SFD-D211). The operation of the FVD and a local translation relay will operate the N2 relay (SFD-D213). The operation of the N2 relay will allow the B 2/5 leads ground to operate the TH 2/5 relays (SFD-D213). The operation of the TH-, HU-, T-, and U- relays will start NG (number group) seizure as shown on SFD-D402. Although the digit information is passed to the OS on SFD-D213, the CM would not operate the KA-KKL (cut-through) relays except on outgoing type calls (SOG, TOG, etc).

D2-3.2.3 No Translation (OA, OB) (SFD-D208)

A marker group may serve several office subdivisions with number groups associated with each office subdivision.

Incoming trunk calls may reach the marker group with only the numerical digits of the called number. To reach the proper number groups, the incoming trunk indicates to the register, and in turn to the marker the office subdivision to which the call should be completed. The trunk may represent a particular office code and is translated in the incoming register to a certain office subdivision. This arrangement is of value for high traffic between nearby offices as it allows the use of four digit called numbers.

When a call in a connecting office is routed to an office that has trunks dedicated to a particular office subdivision, the incoming class may be OA or OB.

The sender in the connecting office receives a delete 3 indication (with a seven digit call) from its CM. The sender will output starting with the D digit. The D digit received by the incoming register will be stored in the A reed pack of the incoming register. The E digit from the sender in the B reed pack, etc.

The IR will pass information to the CM on the A 2/5-D 2/5 leads (SFD-D212). Grounds on the A 2/5 - C2/5 leads will operate the AC 2/5 - CC 2/5 relays. The operation of the OA or OB relay will operate the N1 relay. The operation of the N1 relay will allow the AC 2/5 leads ground to operate the TH 2/5 relays (SFD-D213). The BC 2/5 leads ground to operate the HN 2/5, etc. The operation of the TH-, HN-, T- and U-relays will start NG seizure as shown on SFD-D402. Although the digit information is shown passed to the OS on SFD-D213, the CM would not operate the KA-KKL (cut-through) relays except on outgoing type calls (SOG, TOG, etc.)

D2-4 DIRECT SIGNALS USED IN CONJUNCTION WITH TRANSLATORS

D2-4.1 RO, REORDER

This condition is caused by a register timeout or register detection of a dialing error.

D2-4.2 LR, LINK RELEASE

A link release trouble is due to failure of the register to receive information from the incoming register link.

D2-4.3 DCK, DOUBLE CONNECTION CHECK (SFD-D113)

With the double connection check is operated in the CM, it indicates that the LR indication was not caused by a double connection at the IRL. The DCK punch indication will be shown when a trouble record is taken in conjunction with the LR and the trouble is not caused by a double connection.

D2-4.4 FIRST OR SECOND TRIAL (SFD-D210)

Ground on the TRK lead indicates to the CM a first attempt to complete the call. If the CM fails to complete the call and a second attempt is possible, the CM grounds the TRL (trouble release) lead to the connector which causes the connector to shift start leads and make a second attempt to complete the call.

On the second attempt the TR2 (second trial) lead is grounded and the second trial relay in the CM operates when the marker is seized. The TR2 relay causes the CM to shift preference circuits, to cancel line tests, and causes a BT or trouble release signal to be sent to the register in case trouble prevents completion of the call.

D2-4.5 TRUNK LINK FRAME IDENTIFICATION (SFD-D211)

The trunk link frame number is in two parts, the frame tens number and the frame units number. The tens number is on a one-out-of-three basis and is designated FGO-2. Frame units is two-out-of-five and is designated TFO,1,2,4,7. This information originates from cross-connects in the IRL and passed to the CM from the IR.

D2-4.6 NUMERICAL DIGIT TRANSLATION

The marker must determine which digits of the called number are the office code digits and which are the numerical digits, in order to operate the correct thousands, hundreds, tens and units digit relays. Since the number received may have 0, 1, 2 or 3 digits in the office code (ahead of the line number), the marker provides the N1, N2, N3 and N4 (number translator cut-in) relays which connect the digits registered in the IR to the TH 2/5, HN 2/5, T 2/5, and U 2/5 relays appropriately (SFD-D213).

D2-4.7 TERMINATING CLASS (SFD-D210)

When an INC class signal is received from the IR the TCCK (trunk class check) relay operates. The operation of the TCCK and the OA/OB or the LPA/LPB, etc, relays operate the TER1,2 relays to indicate that the call

is terminating in this office. The operation of the TER1,2 relays cause the FLG (forward linkage ground) relay to operate to cause a linkage from the incoming trunk to a line link appearance to be established as shown on SFD-D603.

D2-5 OPERATION OF THE CKG1,2 GC, GCA, LLC1,2, ONX, TLC1,2 AND BX RELAYS

To provide a large number of off normal grounds and battery potentials to the marker circuit and to interconnect certain functional units, the CKG1,2; LLC1,2; and TLC1,2 relays will be operated.

The operation of the IRMC MA- through ME- relays will extend ground to the CKG lead and will operate the CKG1,2,4,5,6 relays in the marker (SFD-D210). The CKG- relays provide off normal grounds.

The CKG1 relay will operate the BX and ONX relays (SFD-D209). The BX relay provides bias for some of the cross-detecting relays, while the ONX relay provides means for testing for crosses on the select magnet leads.

The operation of the CKG2 relay will operate the TLC1,2 relays (SFD-D209). The TLC1,2 relays provide battery potential for operating the trunk link connector cut-through relays and other miscellaneous off-normal ground and battery functions.

The operation of the CKG4 relay will operate LLC1,2 relays (SFD-D209). The LLC1,2 relays provide battery potential for seizing the line link frame and operating the line link connector cut-through relays. The LLC1,2 relays also provide other miscellaneous grounds and batteries.

The operation of the LLC1 relay will operate the GC or, if provided, GCA relays which provide junctor group control functions (SFD-D617).

D2-6 TEST CALL DIGIT CONTROL (SFD-D217, D218)

On all trunk test classes, when the marker connector relays are operated, the TTL (terminating test line) relay operates. The TTL relay operated, connects the winding of the KA, KB, and KC relays to ground through contacts of any operated A(0-9), B(0-9), and C(0-9) keys or switches (SFD-D212), respectively, and also extends ground to make effective the TTL and BB (busy back) keys (SFD-D217, D218).

The TTL relay operates the K relay which operates the K1 relay (SFD-D217). The K1 is slow operating to allow the slowest K(A-L) relay to operate before continuing the function of the circuit. The operated K1 relay provides ground for the K(A-L) relay contact chain. The last operated K(A-L) relay extends the ground to lead 7 of the next higher lettered digit as an indication to the marker that no further digits are to be expected.

Although any called number can be set up on the A(0-9) through L(0-9) keys or switches, there are certain test numbers which will be used for the majority of tests. An area may have office codes of variable numbers of code digits which means that the numerical digits following a one-digit office code would have to be set on B, C, D, and E keys while the numerical digits following a three-digit office code would have to be on the D, E, F, and G keys.

The TTL key is used to automatically prime the marker with the line number of the terminating test line to the trunk test circuit on IAO and ITNP classes of test which operates the TTL1, TTL3, TTL5, or TTL8 relay depending on the type of terminating test line required.

The TTL key is used to automatically prime the marker with the line number common in the area for the incoming trunk terminating test line circuit on OGT, MISC, and ITDO classes of test which operate the TTL1, TTL2, or TTL7 relay depending on the type of terminating test line required.

The BB key is used to prime the marker with the line number common in the area for a permanently busy line on IAO, ITNP, OGT, MISC, and ITDO classes of test which operates the BB relay.

To use the TTL or BB keys, the office code for the route which includes the trunk to be tested is set up on the called number keys.

A 1-digit code is set up on the A(0-9) key or switch.

A 2-digit code is set up on the A(0-9) and B(0-9) keys or switch.

A 3-digit code is set up on the A(0-9), B(0-9), and C(0-9) keys or switch.

If there is no office code, no called number keys are operated.

When the TTL relay operates, the KA relay operates if any A(0-9) key or switch is operated, the KB relay operates if any B(0-9) key or switch is operated, and the KC relay operates if any C(0-9) key or switch is operated (SFD-D218).

Operation of any TTL- or BB- relay operates the K2 relay which is sufficiently slow-operate to allow time for the KA, KB, and KC relays to operate (if they are going to). The K2 grounds a lead which feeds through transfer contacts of the KA, KB, and KC relays to operate the NA and NAl, number connector, relays (if KA, KB, and KC relays are all normal), to operate NB and NBl relays (if only KA is operated and KB and KC normal), to operate NC and NCl relays if only KA and KB are operated and KC normal, and to operate ND and NDl if KA, KB, and KC relays are operated.

The NA and NAl relays close the thousands cross-connections of the TTL- and BB- relays to the A leads, hundreds to the B 2/5 leads, tens to the C 2/5 leads, and units to the D 2/5 leads, and grounds the E7 lead. The NB and NBl relays shift the TH-, H-, T-, and U- cross-connections to the B, C, D, and E 2/5 leads, and grounds the F7 lead. The NC and NCl relays shift the TH-, H-, T-, and U- cross connects to the C, D, E and F 2/5 leads, and grounds the G7 lead. The ND and NDl relays shift the TH, H, T, and U cross-connections to the D, E, F, and G 2/5 leads and ground the H7 lead.

SECTION D, PART 3

CONNECTION TO THE TRUNK LINK FRAME

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D3 CONNECTION TO THE TRUNK LINK FRAME

When a completing marker has been seized and has received input information through the IRMC, it proceeds to connect to the trunk link frame which contains the incoming trunk.

After the trunk link preference circuit operates, the CM connects to the incoming trunk. Trunk class information is passed from the trunk to the completing marker. The completing marker determines the location of the trunk on the trunk link and operates control relays and select magnets.

D3-1 TRUNK LINK FRAME SEIZURE (SFD-D304)

When the incoming trunk is connected to the incoming register, the trunk link number is transmitted and recorded in the register on the FG0-2 and TFU 2/5 relays (SFD-D1). When the register is connected to the marker through the IRMC, the information is recorded on the marker FG0-2 and TFU 2/5 relays (SFD-D211, D304). The FG- and TFU- relays in conjunction with the TER1 relay closes one of the ST00-29 leads to the TL to operate the preference (MP-/E-) relay, which in turn operates the multicontact connector relays and the marker TFK3 relay.

D3-1.1 PREFERENCE CONTROL CIRCUIT (SFD-D304)

The preference control circuit associated with the trunk link connectors provides two preference relays MP- and E- (marker preference) per marker for each trunk link connector.

There is means for detecting trouble associated with both the MP- and E- relays and for automatically switching from one to the other in the event of detected trouble. The MP- relays are interconnected by three chain circuits which enable connection of one marker at a time to a trunk link frame. Similar independent chains interconnect the E- relays. While the following description is for MP- relays, it applies equally to the E- relays.

D3-1.1.1 MP- Relay Operate Chain

In periods of very light traffic (assuming only one marker at a time applies start battery to bid for seizure of a TL), MP- relay operation is straightforward. A start signal battery from a marker is applied to the associated MP relay winding which is connected through the MP- operate chain to ground at the winding of the first relay in the operate chain.

In periods of heavy traffic, two or more markers may initiate requests either simultaneously or in rapid succession.

Assuming that the first and last markers in the preference chain initiate simultaneous request for connection to the same TL, both MP- relays will operate and lock. If, however, the last marker has initiated a request slightly before the first marker, the MP- relay for the first marker could not have operated because ground for its winding would have been opened by the operate chain at the MP- relay for the last marker. On the other hand, if the first marker initiated a bid first, any other marker ahead of it in the operate chain could subsequently operate its MP- relay.

D3-1.1.2 MP- Relay Work Chain

Since it is possible to operate two or more MP- relays at the same time, two work chains determine which MP- relay does the work. The work chains progress through contacts of the MP- relays in the opposite direction to the operate chain, starting with ground at contacts of the MP- relay for the first marker. If the MP- relay for the first marker is operated, one work chain ground will operate the M trunk link connector relay whether or not other MP- relays are operated. The M relay operates other connector relays by closing through battery supplied by the marker.

The second work chain grounds the CK lead to the marker which has gained access to the trunk link frame to operate the TFK3 (trunk frame check) relay in the marker.

When the marker which has seized the TL has finished its job and opened the start lead to the preference control, its MP relay is released. If there are any other operated MP relays, the next MP relay in the work chain which is operated now functions as just described. This continues until all operated MP relays have been served.

D3-1.1.3 Emergency Transfer

Two sets of preference relays MP- and E- are provided in the preference control either of which can perform the preference job while the other serves as a standby. The CH relay provides trouble detection on the active set of preference relays by monitoring the operate chain and one of the work chains. Assume that the TR key and TR relay are normal so that MP relays are active. When all MP relays are normal, ground through all break contacts of the operate chain is connected to one side of the CH relay winding. The ground through all break contacts of the work chain which operated connector relays is connected to the other side of the CH relay winding. The CH relay cannot operate with ground on both sides of its winding. When one or more MP relays operate, both preference chains are opened to remove ground from both sides of the CH relay winding leaving resistance battery connected to both sides of the winding. Again the relay cannot operate. If, however, all break contacts

of either chain do not conduct, or if a wire is broken when the MP relays are all normal, one side of the CH relay winding will have ground and the other resistance battery which will operate the CH relay. Also, if any of the break contacts fail to open or if there is a false ground on either chain when one or more MP relays operate, the CH relay will again have resistance battery on one side of its winding and ground on the other and will operate.

If the CH relay operates, even momentarily, the TR relay operates and locks. The TR relay operates TR- relays which transfer the SF, CK, and MC leads from MP relays to E relays. The TR relay also brings in a minor alarm and lights a CH lamp.*

The alarm can be restored by momentarily operating the AR key located at the frame or can be restored remotely via the alarm sending circuit. Release of the alarm also restores operation to the MP chain if the TR key is normal or to the E chain if the TR key is operated.

D3-1.1.4 Manual Transfer

By operating the TR key, located at the trunk link connector control frame, preference control can be manually transferred from the MP to the E relays. The TR key operates the TR- relays which remain operated to accomplish the transfer as described previously. The TR key also connects the CH relay to chains of the E relays. If the CH relay operates, it operates the TR relay which locks and releases the TR- relays to transfer preference back to the MP relays.

D3-2 TRUNK SEIZURE (SFD-D306)

On INC type calls, trunk seizure is straightforward. The trunk that initiates the request and information where the trunk is located on the trunk link frame is passed to the completing marker. The actual connection of the marker to the trunk is as follows.

The operated TFK3 relay connects battery to the F lead through the IRMC and the IRL to operate the F relay of the trunk involved on the call. The F relay, in operating, operates its associated FA-- or FB-- relay in the trunk link frame so that operating and test leads may be cut-through to the marker.

* Although the CH lamp is shown as part of the trunk link connector circuit, it and the alarm release key are located on a frame designated as "trunk link connector control".

D3-3 LOCAL TERMINATING CLASS (SFD-D306)

Local terminating class of calls require that an indication be sent to the completing marker to determine which office the call will complete to. An incoming trunk RCA/RCB to RC-- cross-connect at the TL (SD-27879-01) and the KT to ONN-9NP cross-connect at the TL (SD-26032-01), through the operated FA-- or FB-- relays, is the source of trunk class relay (ONN-9NP) operation in the marker. These relays in the marker do triple duty as originating trunk recorder numbers, pulse conversion trunk OS class, and incoming trunk office indication and type of supervision. Table A shows the terminating class information and its component parts.

TABLE A

TERMINATING CLASS

SD-27879-01	SD-26032-01	RECORDER NO.	SUPERVISION*	OFFICE**
RC09	9NP	9	N	P
RC08	8SP	8	S	P
RC07	7RN	7	R	N
RC06	6NT	6	N	T
RC05	5ST	5	S	T
RC04	4NE	4	N	E
RC03	3NA	3	N	A
RC02	2SA	2	S	A
RC01	1SE	1	S	E
RC00	ONN	0	N	N

* N - No supervision required on free numbers

S - Supervision required

** P - Physical

T - Theoretical

E - Extra-theoretical

A - All 5-7 digit incoming

D3-3.1 NUMBER SERIES GROUP

A marker group is arranged to handle a maximum of six office codes spread over six number series with a maximum of 40,000 numbers.

A maximum of three discriminating treatments by office codes is permissible within a number series group. The local completion discriminating marks for a 5, 6, or 7-digit terminating connection are LPA, LTA, and LEA for number series group A and LPB, LTB, and LEB for number series group B. For a 4-digit incoming connection the incoming trunk group discriminating marks are 8SP or 9NP, 5ST or 6NT and 1SE or 4NE, with a nondiscriminating mark 2SA or 3NA. For a 4-digit incoming connection the number series group mark is 0A or 0B.

D3-3.2 SUPERVISION REQUIRED

Supervision may be required to insure that a called line answer indication is transmitted back to the calling office so that a charge can be made.

Supervision is in the form of a tip and ring reversal caused by the operation of the trunk, T, relay.

To operate the T relay, trunk classes (8SP, 5ST, etc.) redirect free number ringing combinations to set the ringing switch to level 6. Ringing combination 6 insures that the trunk, T, relay operates on called line answer and disallows a free number (no charge) termination.

D3-3.3 NONSUPERVISION REQUIRED

Terminating classes (9NP, 6NT, etc.) are used when the call is free (not billed).

Free number NG ringing combinations 08 and 09, together with no-supervision trunk classes, set the ringing switch to level 8 which does not provide operate ground for the trunk, T, relay.

D3-4 OPERATION OF CONTROL RELAYS AND SELECT MAGNETS IN THE TRUNK LINK (SFD-D307)

When the F relay in the trunk is operated, it operates an FA-- or FB-- relay. The FA-- or FB-- then operates a LV0-9 relay. There is one LV0-9 relay associated with each of the levels (horizontal) of the trunk switches.

Assume that a B appearance is involved and the FB-- relays operates. When one FB-- and one LV-- relay operates, several leads are connected to the marker through the TLC. These are the following:

- (a) The FBK informs the marker that the trunk is on the B appearance and checks the operation of the FB-- relay.
- (b) The BST connects the crosspoint sleeve into the marker for test purposes when crosspoints are being set up.
- (c) The BSM connects the associated directing and trunk select magnets into the marker.
- (d) The BLC connects an operating circuit, for the link connector relay associated with the trunk switch in which the trunk appears, into the marker.

If the A appearance is involved, the leads would be FAK, AST, ASM, and ALC respectively.

SECTION D, PART 4

CONNECTION TO THE NUMBER GROUP FRAME

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D4 CONNECTION TO A NUMBER GROUP

In a No. 5 crossbar office, there is no permanent or prearranged association of directory numbers with switch positions on the line link frames. A marker upon receiving the number for a terminating call must determine which one of the many switch verticals in the office is associated with that particular directory or trunk number so that a connection may be established. The marker obtains this information from the number group frame. This frame is a large central memory kept up to date with the latest directory number assignments, to which each marker in turn applies for the necessary translation.

D4-1 CAPACITY OF THE NUMBER GROUP

The No. 5 crossbar marker group is equipped for a maximum of 40,000 numbers (directory and trunk) arranged for six number series, as follows:

<u>Number Series Group A</u>	<u>Number Series Group B</u>
No. Series 0	No. Series 1
No. Series 2	No. Series 3
No. Series 4	No. Series 5

Each 1000 directory numbers comprise a number group. A marker group can accommodate 40 such number groups or a total of 40,000 directory numbers including trunk numbers. Number groups are provided to fill the needs of the respective number series and should be considered as independent of number series groups. The frames are numbered as they are added from 00 through 39.

D4-2 NUMBER SERIES START, NSSO-5 (SFD-D407)

The number series start relays are used to direct the completing marker to a start lead to seize a number group frame.

Ground is extended through the relays in the completing marker associated with the directory number of the called customer to be translated. This is a check that the two-out-of-five relays have operated which are the U2/5, T2/5, HN2/5, and TH2/5. The ground also extends through local translation relays, for 5- and 7-digit calls or through terminating class relays if the incoming call is 4 digits.

When the TFK3 relay (SFD-D302), the SNG2 (SFD-D408) and TH2/5 relays operate, the MP- (marker preference) relay in the number group preference control and make-busy circuit operates (SFD-D409). This seizes

the NGC (number group connector), which connects the marker to the NG by operating the connector multicontact relays. The connection to the NG by the marker is checked by the operation of the NGK and NGK1 relays and their associated punches.

In offices where unused hundred series of numbers exist in a number group, a second thousand series of numbers in the same office code group may be put into the NG to use the unused hundred series of numbers. In such offices, the ST- terminal associated with the added thousand series is cross-connected to the AS terminal and causes the operation of the AST (additional start), relay. Battery is then extended through the AST relay and an NSS- relay to an AST0-5 terminal, which is cross-connected to the ST- terminal of the NG containing the partially used series. The MP- relay associated with the marker then operates (SFD-D408,D409).

D4-3 OFF NORMAL CONTROL

When the FLG (forward linkage ground) relay and local translation relays operate, the completing marker operates relays that will control information to and from the number group.

The FLG operates the SNG1,2 relays. These relays control the operation of the MCB-MCE relays in the NGC (SFD-D408) and in conjunction with the HN-, TN-, and U- relays will operate translation relays in the number group (SFD-D410). The local translation relays, LPA/LPB, etc, will operate the LLI (line link idle) relay, the NGC (number group control) relay, and the UC (units cut-in) relay to further control the translation of the called directory numbers to a line location and ringing combination.

D4-4 PREFERENCE CONTROL CIRCUIT (SFD-D409)

The preference control circuit associated with the number group connectors provides two preference relays MP- and E- (marker preference) per marker for each number group connector.

There is means for detecting trouble associated with both the MP- and E- relays and for automatically switching from one to the other in the event of detected trouble. The MP- relays are interconnected by three chain circuits which enable connection of one marker at a time to a number group frame. Similar independent chains interconnect the E- relays. While the following description is for MP- relays, it applies equally to the E- relays.

D4-4.1 MP- RELAY OPERATE CHAIN

In periods of very light traffic (assuming only one marker at a time applies start battery to bid for seizure of a NG), MP- relay operation is straightforward. A start signal battery from a marker is applied to the associated MP- relay winding which is connected through the MP- operate chain to ground at the winding of the first relay in the operate chain.

In periods of heavy traffic, two or more markers may initiate requests either simultaneously or in rapid succession.

Assume that the first and the last markers in the preference chain initiate simultaneous request for connection to the same NG. Both MP- relays will operate and lock. If, however, the last marker has initiated a request slightly before the first marker, the MP- relay for the first marker could not have operated because ground for its winding would have been opened by the operate chain at the MP- relay for the last marker. On the other hand, if the first marker initiated a bid first, any other marker ahead of it in the operate chain could subsequently operate its MP- relay.

D4-4.2 MP- RELAY WORK CHAIN (SFD-D409)

Since it is possible to operate two or more MP- relays at the same time, a work chain determines which MP- relay does the work. The work chain progresses through contacts of the MP- relays in the opposite direction to the operate chain, starting with ground at contacts of the MP- relay for the first marker. If the MP- relay for the first marker is operated, the work chain ground will operate the number group connector, MCA, relay whether or not other MP- relays are operated. The MCA relay operates the MCB-MCE relays by closing through battery supplied by the marker.

When the marker which has seized the NG has finished its job and opened the start lead to the preference control, its MP-relay is released. If there are any other operated MP- relays, the next MP- relay in the work chain which is operated now functions as just described. This continues until all operated MP- relays have been served.

D4-4.3 EMERGENCY TRANSFER (SFD-D409)

Two sets of preference relays MP- and E- are provided in the preference control either of which can perform the preference job while the other serves as a standby. The CH relay provides trouble detection on the active set of preference relays by monitoring the operate chain and one of the work chains. Assume that the TR key and TR relay are normal so that the MP- relays are active. When all MP- relays are normal, ground through all the break contacts of the operate chain is connected to one

side of the CH relay winding. The ground through all the break contacts of the work chain which operated connector relays is connected to the other. The CH relay cannot operate with ground on both sides of its winding. When one or more of the MP- relays operate, both preference chains are opened to remove ground from both sides of the CH relay winding leaving resistance battery connected to both sides of the winding. Again the relay cannot operate. If, however, all break contacts of either chain do not conduct, or if a wire is broken when the MP- relays are all normal, one side of the CH relay winding will have ground and the other resistance battery which will operate the CH relay. Also, if any of the break contacts fail to open or if there is a false ground on either chain when one or more MP- relays operate, the CH relay will again have resistance battery on one side of its winding and ground on the other and will operate.

If the CH relay operates, even momentarily, the TR relay operates and locks. The TR relay operates TR- relays which transfer the ST-, TMB, and MC leads from MP- relays to E-relays. The TR relay also brings in a minor alarm and lights a CH lamp.*

The alarm can be restored by momentarily operating the AR key located at the frame or can be restored remotely via the alarm sending circuit. Release of the alarm also restores operation to the MP- chain if the TR key is normal or to the E- chain if the TR key is operated.

D4-4.4 MANUAL TRANSFER

By operating the TR key, located at the connector control frame, preference control can be manually transferred from the MP- to the E-relays. The TR key operates the TR- relays which remain operated to accomplish the transfer as described previously. The TR key also connects the CH relay to chains of the E- relays. If the CH relay operates, it operates the TR relay which locks and releases the TR-relays to transfer preference back to the MP- relays.

D4-5 NUMBER GROUP TRANSLATION

After seizing the number group, the marker connects -48 volts through resistance lamps, to the hundreds, tens, and units leads, as determined by the operated HN-, TN-, and U- relays, to select one terminal from the 1000 sets of number terminals. The number group translates the directory number, represented by this one terminal, into line location and ringing combination and passes this information to the marker.

* Although the CH lamp is shown as part of the number group connector circuit, it and the alarm release key are located on a frame designated as "number group connector control."

D4-5.1 HUNDREDS BLOCK, HB0-9 (SFD-D410)

A HB0-9 relay in the NG is associated with the hundreds digit of the called number. Battery is extended to the NG over the HB0-9 leads associated with the HN2/5 relays to operate a HB0-9 relay in the NG.

D4-5.1.1 Rate Treatment Discrimination (Physical, Theoretical, and Extra-Theoretical Numbers) (SFD-D411)

The operation of the NG HB0-9 relay places ground on the PT cross-connection terminal associated with the HB relay. The cross-connections for the PT terminals are made in accordance with the cross-connection information shown in the NG. These cross-connections provide discriminating marks which are designated PN, TN, EN and PTN or if the number is part of an added thousand series, the designations are PN1, TN1, EN1, and PTN1. If the PN1, TN1, EN1, or PTN1 terminal is grounded the marker compares this fact with the operated AST relay. If they do not agree, the blank number thousands relay operates. The information received from the number group (PN, TN, EN, or PTN) is matched against the local completion relay information that the marker used in selecting the NG. If a match is made, the PTK relay operates (SFD-D411).

D4-5.2 TENS BLOCK, TB00-99 (SFD-D410)

A TB00-99 relay in the NG (associated with the tens and hundreds digit of the called number) is operated to indicate the 100 groups of ten directory numbers in which the called number is located. The PN, TN, EN, or PTN relay closes battery to the NG over the one TB0-9 lead associated with the operated T2/5 relays. The TB- lead is extended in the NG through the HB- relay contacts to operate the one TB00-99 relay associated with the tens digit and hundreds digit of the called number. The marker TBW (tens block wetting) relay, operates in series with the NG TB- relay and checks that the operate path has been completed.

D4-5.2.1 Tens Block Screening Provided

When tens block screening is provided, cross-connections are made in the number group so that TBS1/4 relays in the number group operates in series with the TB-- relay. This indication is passed to the marker to operate the corresponding TBS- relay in the marker (SFD-D410). The particular TBS- relay that is operated can screen certain ringing combinations to give four different meanings to each ringing combination depending on the group of tens blocks in which the line is located.

D4-5.3 UNITS NUMBERS, U0-9 (SFD-D413)

A U0-9 relay in the NG is operated when the NGC relays close the U0-9 leads from the marker to the NG. Battery is closed through the operated U2/5 relays, and through the UC (units cut-in) relay, in the marker to one of the U0-9 leads to the NG. The operation of the NG U- relay extends ground over the UK lead to the marker, operating the UK (units check) relay, which checks that the NG units relay has operated.

D4-5.4 TRANSLATED INFORMATION PASSED TO THE COMPLETING MARKER (SFD-D414)

Each of the 1000 numbers in a NG has three terminals designated L, G, and F. Each of the 1000 numbers also has three separate fields of cross-connection terminals. These three fields consist of the LL, VHG, and RF terminals. The translator gives information about the called number over two sets of leads from each cross-connection.

The hundreds, tens, and units digit transmitted to the NG by the marker determine which set of L, G, and F terminals are connected to battery from the marker over the WL, WG, and WF leads.

The L terminals is cross-connected to an LL- terminal, which extends battery over the FT0-5 leads and FU0-9 leads to cause operation of the proper FTN0-5 (frame tens number) relay, and FUN0-9 (frame units number) relay in the marker.

The G terminal is cross-connected to a VHG- terminal, which extends battery over the HG0-9 leads and VG0-11 leads to cause operation of the proper HGN0-9 (horizontal group number) relay, and VGNO-11 (vertical group number) relay in the marker.

The F terminal is cross-connected to an RF- terminal, which extends battery over the RC1-15 and VF0-4 leads to cause operation of the proper RCN1-15 (ringing combination number) relay, and VFNO-4 (vertical file number) relay in the marker.

This information is then stored on the corresponding FTT-, FUT-, VGT-, HGT-, VFT-, and RCT- relays which lock through their associated FTL, FUL, VGL, HGL, VFL, and RCL relays located on SFD-D415, D417.

To check that the lock relays operate, the LA (lock auxiliary) relay operates in the marker (SFD-D417). To check that one and only one line location relay has operated, the HTK1, VTK1 and FTK1 relays operate and ground the associated punch (SFD-D417).

D4-6 INTERCEPT TREATMENT

The marker connects the calling line to intercept under the following conditions:

- (a) A blank number is called.
- (b) A changed or disconnected number is called.
- (c) A temporarily disconnected number is called.
- (d) A number associated with the line link appearance of a trunk is called.
- (e) The physical and theoretical match is not made.

The conditions listed above cause the operation of one of the intercept relays listed below:

- (a) BN - This causes the calling line to be connected to a no-such-number tone trunk or a machine intercept announcement.
- (b) RI - This causes the calling line to be connected to a regular intercept trunk.
- (c) OVC/PMO - This causes the overflow tone ringing condition to be set up on the ringing selection switch.
- (d) RIP - This causes the calling line to be connected to a PBX recorded announcement.

D4-6.1 BLANK NUMBER AND REGULAR INTERCEPT

Some of the intercept conditions listed above are enabled by removing one or more number group cross-connections as described in paragraphs SCD-D4-6.1.4 and D4-6.1.5. In order to determine if intercept is required, the marker starts the TYM timing circuit when relay HTUK operates (SFD-D411). If the called number is not to be intercepted, it is translated, the number group released, and the TYM timer recycled before the end of the timing period. Under this condition the call proceeds in the usual manner. However, if the called number is to be intercepted, the TYM timer times-out and operates the TYM and TYMA relays (SFD-D403, D411).

The operation of relay HTUK removes ground from the secondary winding of the TYM and the short circuit from the TYM1,2 capacitors. This permits the TYM1,2 capacitors to charge through the secondary winding of the TYM

relay and TYMO resistor. After an interval of time, the capacitor will be fully charged and the current flow through the secondary winding will cease. The TYM relay then operates on its primary winding in series with the TYM1 resistor.

The operation of relay TYM operates the TYMA relay, which extends ground through the nonoperated line identification relays to the intercept cross-connection terminals (SFD-D419).

D4-6.1.1 Called Number Associated with Unequipped Number Group

When the called number thousands digit represents an unequipped NG, the marker proceeds with its functions up to the selection and seizure of a NG. Then, when the marker extends battery to an ST- lead, a NG is not seized. The battery on this ST- lead is extended to the associated ST- cross-connection terminal. This ST- cross-connection terminal is cross-connected to the BNTH cross-connection terminal, thereby extending battery to operate the blank number thousands or hundreds BNTH relay (SFD-D408, D411).

D4-6.1.2 Called Number Associated with Blank Hundreds Group

When the called number is one of a blank hundreds group, the marker proceeds until NG translation is required. Then, the operation of the number group HB- relay extends ground to the PT cross-connection terminal in the NG. When the hundreds group has only blank numbers, the PT cross-connection terminal is cross-connected to the BNK terminal in the NG thereby, extending ground over the BNK lead to operate the BNTH relay in the marker (SFD-D411).

The operation of the BNTH relay extends ground to the BTI cross-connection terminal. These terminals are cross-connected to the BN, RI, or RO cross-connection terminals (SFD-D419).

D4-6.1.3 Called Number is a Changed or Disconnected Number or is an Individual Blank Number that is Treated as a Disconnected Number

When the called number is a changed or disconnected number, or is an individual blank number that is treated the same as a disconnected number, the marker proceeds with its functions until NG translation is required. However, in the NG, the cross-connections to the L-, G-, and F- cross-connection terminals for this called number are omitted. Therefore, the called line identification relays in the marker do not operate. The operation of the timer extends ground to the NI cross-connection terminal which is cross-connected to the appropriate intercept relay (SFD-D419).

D4-6.1.4 Called Number is an Individual Blank Number that is Treated Differently from a Disconnected Number

When the called number is an individual blank number or an unassigned number, and it is treated differently from a disconnected number, the marker proceeds with the connection until NG translation is required. In the NG, the cross-connections to the L- and F- terminals are omitted, but the G- terminal associated with the called number is cross-connected to the VHG- terminal. Battery is extended through the NG and operates the VGN- and HGN- relays in the marker. The VGN- and HGN- relays cause the VGL and HGL relays in the marker to operate as described in SCD-D4-5.4.

The TYM timing circuit functions as described. Upon timing out the TYMA relay extends ground to the GI cross-connection terminal through the operated VGL and HGL relay contacts and the nonoperated VFL, RCL, FTL, and FUL relay contacts. This terminal is cross-connected to the RI or BN terminals depending on the type of intercept treatment desired (SFD-D419).

D4-6.1.5 Called Number is an Individual Number that is Temporarily Disconnected

When the called number is an individual number that has been temporarily disconnected, the marker proceeds with the connection until NG translation is required. In the NG the G- and F- cross-connection terminals are cross-connected to the VHG- and RF- terminals. The cross-connection to the L- terminal in the NG is omitted. Marker relays VGL, HGL, VFL, and RCL are operated as a result of these cross-connections in the NG and the FTL and FUL relays in the marker are nonoperated.

Since a complete NG translation cannot be made the TYM timer times-out and operates the TYMA relay. The TYMA relay causes ground to be extended through the operated VGL, HGL, VFL, and RCL relay contacts, and the nonoperated FTL and FUL relay contacts to the TI cross-connection to the RI or BN terminals for the desired intercept treatment (SFD-D419).

D4-6.1.6 Physical and Theoretical Match

If the physical and theoretical check between the trunk class or local completion relays and the output of the number group does not match, ground is placed on the NMI punching. This terminal is cross-connected for the desired intercept treatment (SFD-D409, D419).

D4-6.2 TROUBLE INTERCEPT CONNECTION

When the marker determines that a connection to the called number cannot be completed because the customer's line is out-of-service, the marker connects the calling customer to a trouble intercept trunk. The trouble intercept trunk connects the calling customer to an operator.

The trouble intercept trunks terminate on the LL. Therefore, in setting up a trouble intercept trunk connection, a connection is established from the LL associated with the trouble intercept trunk to the TL associated with the ITR or TER trunk.

D4-6.2.1 Call to a Non-PBX Number

If the call is for a non-PBX number, the line out-of-service is plugged-up on the MDF. When the line is plugged-up, battery on the ring conductor and ground on the tip connector indicate to the marker that the call should be routed to a trouble intercept trunk.

D4-6.2.2 Call to a PBX Number

On calls to nonhunting numbers, which are plugged-up, the marker distinguishes the plugged-up condition by finding the proper potential on the tip and ring conductors. This method cannot be used on calls to hunting numbers, because improper operation of the PBX may present a condition on the tip and ring conductors that looks to the marker like the plugged-up line signal.

If it is desired to take out of service one or more lines, but not all lines of a PBX line group, those lines that are to be removed from service are made busy. The marker in performing the terminal hunting functions selects only those lines in the PBX line group that are idle or not made busy. The marker operation for this condition is similar to that described for terminal hunting covered in SCD-D4-7.

If it is desired to take out of service all of the lines in a PBX line group, they are all made busy, except the first PBX line, which is the directory number. The G- and F- cross-connection terminals in the NG which are associated with the first PBX line, are disconnected. Therefore, the marker, in performing the NG translation, recognizes that only the L- terminal is cross-connected in the NG and a connection to a trouble intercept trunk is established.

The marker proceeds to the usual manner until NG translation is received. In the NG, the cross-connections to the G- and F- cross-connection terminals are omitted and only the L- terminal is cross-connected to the LL-terminal. Battery is extended through the NG to operate the FTN- and FUN- relays in the marker, and the FUL and FTL relays, in the marker are operated.

The marker starts the TYM timing circuit when the HTUK relay operates, and a time-out results. The TYMA relay, in operating, extends ground through the operated FUL and FTL relay contacts and nonoperated VGL, HGL, VFL, and RCL relay contacts to the winding of the PUL relay, which operates. The PUL relay operates the trouble intercept TBL relay to start a connection to a trouble intercept trunk (SFD-D419).

D4-6.3 VACANT AND DENIED CODE INTERCEPT

The marker is arranged to intercept unused or vacant codes usually contained in the area numbering plan and certain codes denied to specific types of incoming trunks because of rate discrimination. Incoming trunks with only trunk link frame appearances may be arranged to return reorder on vacant or denied line numbers, or these trunks may be arranged to set vacant or denied line numbers to intercept trunks on the line link frame.

Denied or nonworking code points (in some cases screened through the S relay) that enter the marker group over incoming trunks are either cross-connected to operate the DCI (denied code intercept) relay, or the VCI (vacant code intercept) relay. The operation of the DCI or VCI relay will operate the BN and RI relays respectively, as well as the TER1-2 relays which marks this call as a terminating call, the BN relay with the DCI relay operated will operate the DCIA (denied code intercept auxiliary) relay. The RI relay with the VCI relay operated will operate the VCIA (vacant code intercept auxiliary) relay. The call then progresses as a terminating call that has encountered a blank number or regular intercept condition. The marker transmits the DCIA or the VCIA line number information to the number group and obtains from it the line link frame location of the intercept trunk. This intercept trunk link number is placed on the HB-, TB-, and U- leads to the NG by associated cross-connections (SFD-D410, D413).

D4-7 TERMINAL HUNTING (SFD-D406)

Terminal hunting is the function performed by the CM (completing marker) and NG (number group) in searching for an idle line or trunk in a group of lines or trunks. If the called line or trunk is busy, another line or trunk within the group may be selected.

Terminal hunting is used when more than one line or trunk is grouped with one number such as:

- (a) A number used to identify a PBX line group.
- (b) A number used to identify a group of trunks appearing on line positions and used for calls requiring regular or trouble intercept.
- (c) A number used to identify a group of trunks appearing on line positions and used as a routing for calls where the dialed number is a blank number.

Lines in a terminal hunting group require different treatment in the NG than nonterminal hunting lines as follows:

- (a) All the lines in a terminal hunting group must use the same office code.
- (b) A nonallotted terminal hunting group may be distributed among several tens and hundreds blocks, but must remain within one NG.
- (c) The cross-connection for the G, L, and F terminals in the NG are the same for terminal hunting and nonhunting lines. However, for terminal hunting the F terminal is always cross-connected to an RF terminal associated with ringing combination RC10.

D4-7.1 PBX HUNTING

On PBX lines, the CM and NG proceed to translate the called directory number into equipment location and ringing combination in the same manner as for a non-PBX line. However, after the equipment location and ringing combination of the called line have been received, the CM recognizes from the ringing combination that terminal hunting is required. Ringing combination RC10 is used to indicate that a line is in a terminal hunting group.

When the CM recognizes RC10, it releases the called line location identification relays. The CM and NG then proceed with the selection of an idle line. To allow the CM and NG to hunt for an idle line within the terminal hunting group, the sleeve conductors within a tens block are extended to the CM. The CM tests these conductors for an idle condition (battery through the line hold magnet is recognized as an idle indication) and selects an idle line. The NG then transmits to the CM the line location information of the selected line.

D4-7.1.1 Hunting Within One Tens Block

The circuit operation for a call to a terminal hunting line is the same as that for a nonhunting line up to the ringing combination indication. The CM operates the RCN10 and RCT10 relays indicating ringing combination ten is to be used (SFD-D415). The PBX1-2 relays operate, indicating that the directory number is in a PBX (Private Branch Exchange) terminal hunting group (SFD-D418).

To extend the sleeve conductors of lines in a PBX group to the marker, a number group SC- relay is provided for each tens block. In addition, a TBA relay is provided for those tens blocks that have more than one PBX group (SFD-D425). In tens blocks where lines of a single PBX appear, the SC- relay operates in parallel with the NG TB00-99 relay.

In tens blocks where more than one PBX appears, the NG TBA relay operates with the tens block relay. The selection of the proper SC- relay is determined by the TBA and U0-9 relays. The SLCK (sleeve check) relay is closed through to the NG over the SCK lead and operates to check the operation of the NG SC- relay (SFD-D425). The SLCK relay operating:

- (a) Operates the SAC (SA- connector) relay allowing registration of idle line information (SFD-D418).
- (b) Locks under control of the GB (group busy) relay released.
- (c) Operates the CKO (check relays operated) which release the LLI (lock line identification) relay and the SNG1,2 relays (SFD-D419, D408).

The line identification and NG multi-contact relays release. After the line identification relays are released, the CKR (check release) relay operates to prepare for the new line identification and provision is made, through the CKO relay make contact, to operate the RYT for recycling the WT timer (SFD-D418).

D4-7.1.2 Sleeve Test

The NG SC- relay extends the sleeves of the lines over the S0-9 leads to the marker SLO-9 (sleeve test) relays (SFD-D424). Cross-connections are provided to connect the sleeves of lines within a terminal hunting group. If the line is busy, ground is applied to the sleeve lead, or if the line is idle, battery is applied through the LL hold magnets. Therefore, an SLO-9 relay in the marker operates for each idle line within the selected tens block. A set of SA0-9 relays records those PBX hunting lines that are idle at that time (SFD-D424). To prevent any interference from other PBX lines that may become idle after the sleeve test, the SA- relays operated, operate the SAE (sleeve auxiliary end) relay, which releases the SAC relay (SFD-D418), opening the SA- relay operate path. The lowest numbered operated SA- relay, equal to or greater than the called number units digit closes its U- lead to the NG (SFD-D413). The SAE relay operated also reoperates the SNG1,2 relays which reoperate the NG multi-contact relays (SFD-D408). The NG now proceeds to provide a translation for the idle PBX line.

D4-7.2 BLOCK HUNT/SELECT OPERATION (SFD-D406)

Where lines of a terminal hunting group are distributed over one or more tens blocks, the CM and NG first test for an idle line in the first tens block. Where the hunting group is confined to a single tens block, and all lines of the hunting group are busy an EG (end of group) relay operates to inform the CM that no further hunting should be attempted (SFD-D425). The GB (group busy) relay also operates and causes the call to be connected to a tone trunk (SFD-D413).

Where more than one tens block is involved in the hunting group and no lines are idle in the first tens block, the CM and NG advance to another tens block. In this manner, all terminal hunting lines within all tens blocks of the hunting group can be tested until an idle line is found. Advancing from one tens block to another can be accomplished by the BLOCK HUNT or BLOCK SELECT method, depending on which of these features is used.

In the block hunt method, after the CM has determined that no idle lines of the terminal hunting group exist in the tens block being tested, it advances to another tens block. The CM then hunts through this tens block. The order of advance is predetermined by cross-connections in the NG.

In the block select method, after the CM has determined that no idle lines of the terminal hunting group exist in the tens block being tested, it tests for a tens block having idle lines of the terminal hunting group and selects the tens block. The order of advance is predetermined, but it is contingent on the existence of idle lines in a tens block.

The completing marker A(advance) relay operates from the SLCK relay and locks under control of the SCR (SC- release check) relay normal (SFD-D418, D425). The A relay operated prepares for block hunt or select to allow selection of a second tens block. The operation of the A relay extends battery over the OA lead to the A cross-connection terminal in the NG. By means of NG cross-connections A to AD or A to AS, the A relay or SA (sample) relay operates for either block hunt or block select, respectively (SFD-D425). To check the operation of either of these relays, ground is extended over the AK lead to the marker which operates the AK (advance check) relay (SFD-D418).

The A or SA relay in the NG operates so that if there are no idle PBX lines within the first tens block, the CM is able to select a second tens block in the hunting group.

To provide sufficient time for any SA- relays to operate from the first tens block, the AK relay operates the TYMA (SFD-D411). When the TYMA relay operates, and if none of the SA- relays are operated, the GB relay operates to indicate that all lines within the first tens block are busy (SFD-D413). The GB relay causes the release of the NG hundreds and tens block relays by removing the battery from the LHB lead (SFD-D410) and ground from SCK lead (SFD-D425), to the NG. This also causes the release of the SLCK relay (SFD-D425) when the CM advances to test the lines associated with the hunting group in the second tens block, it must be able to select any one of the lines regardless of the number dialed. The UT (units transfer) relay operates to start the hunting, beginning with the first line in the tens block (SFD-D420). This is done by transferring the operating path of the NG U0-9 from the control of the CM U2/5 relays to the UT relay (SFD-D413).

The CM SCR relay has been shunted by the NG SC relay operated. The release of the SC relay is thus checked by the operation of the SCR relay. The SCR relay operates in series with the winding of the NG A or SA relay, which was previously operated and releases the CM A relay.

If the NG is arranged for block hunt operation, battery on the OTB lead is extended from the CM to operate a predetermined TB- (tens block) relay and an SC- relay associated with the second tens block of the hunting group. If block select operation is used, the NG TB- and SC- relays operate in tens block in which idle lines of this terminal hunting group appear.

The CM GB relay releases and causes the SLCK relay to reoperate over the SCK lead. This checks the operation of the NG SC- relay for the second tens block. The CM and NG then test for an idle line in this tens block of the hunting group in the same manner as previously described.

Whether the NG is arranged for block hunt or block select operation, it is possible that all lines of the terminal hunting group in the second tens block are busy. In block hunt operation, since selection of a second tens block is predetermined by cross-connections, it is possible that all lines in the second tens block are busy prior to its selection. In block select operation, where a second tens block is chosen on the basis that idle lines appear there, it is still possible for another CM to make a connection to the last idle line in the tens block during the interval of selecting the second tens block and the start of hunting by this CM.

If all the lines of a terminal hunting group are found busy, the NG and CM advance from tens block to tens block until informed by the CM EG relay operation that the last tens block of the hunting group has been reached. When arranged for block select operation and all lines are found busy, the EG relay operates immediately and no further hunting is attempted.

Where lines are found idle during the hunting operation, the CM SA0-9 relays operate to identify these lines. The SAE relay operates to signal the NGC (number group connector) relays to reoperate and close through the U0-9 leads to the CM. The NGK1 (number group check) operates over the W lead to check the additional operation of NG multi-contact relays. During first trial calls with the TR1A relay operated, the selection of the NG U0-9 relay is made through the lowest numbered SA0-9 relay operated. Under second trial conditions, the selection is reversed through the highest numbered SA0-9 relay operated. With the units number recorded in the NG the CM is able to proceed with a translation of the number of the selected line into its associated equipment location (SFD-D413).

D4-7.3 PBX ALLOTTER (SFD-D404)

The PBX allotter feature provides means of recognizing calls to as many as 10 PBX terminal hunting groups. The lines of each terminal hunting group may be distributed over as many as 8 NG's. The lines of a PBX terminal hunting group are referred to as an allotter group, and the lines of this allotter group may be referred to as belonging to line groups on each NG containing lines of the allotter group.

As many as 5 such line groups, each associated with a different allotter group may appear on one NG. Only 4 of the possible 10 allotter groups may have lines distributed over 8 NG's. The other 6 allotter groups must have its lines confined to 4 or less NG's.

In these offices equipped with the PBX allotter feature, the CM first examines the called number to see if the number is an allotted directory number. Only directory numbers can be so recognized. If the number is allotted, the marker tests for an idle line in the same line group of this allotter group before seizing a NG. When the marker subsequently seizes the NG containing an idle line, it is prepared to hunt for the idle line.

If a call is made to a number in the allotter group other than the directory number, the CM does not recognize it as an allotted number, and treats it as an ordinary PBX line. In this case, the NG is seized first and ringing combination 10 indicates a PBX line. The marker then proceeds to select an idle line by the terminal hunting operation as described in SCD-D4-7.1.

D4-7.3.1 Identification of Allotted Number

Various operating grounds for the allotter operation are supplied by the ANON (allotted number off-normal) relay, which is operated by the CKG6 relay, when the marker is seized (SFD-D420).

The marker is arranged to handle a maximum of 40,000 lines distributed over as many as six number series. To indicate the office number series of a called number, the marker operates one NSS0-5 relay. An ALS0-5 (allotter start) relay is operated in parallel with the NSS- relay and starts the PBX allotting functions for the particular office number series (SFD-D407).

Where particular office number series do not contain any allotted numbers, cross-connections are provided for seizure of a NG without any allotter functions. The ALS0-5 cross-connection terminal is cross-connected to the NAN terminal for those number series containing no allotted numbers. This cross-connection provides a saving of marker holding time when no allotting is necessary in a particular number series.

Where office number series contain allotted numbers, the PBX allotter must first determine if the called number is or is not in an allotted hunting group.

An allotted directory number is indicated by the operation of the AN (allotted number) relay (SFD-D423). The ANAO-9 relay, operating in series with the AN relay, indicates the hunting group to be selected. The PBX allotter feature is canceled for special calls when the SPL1 relay operates.

To direct the marker in selecting the particular ANAO-9 relay that contains the directory number, the thousands THT0-9, hundreds HBT0-9, and tens TBT0-9 cross-connection terminals are cross-connected to the ATH-, AHB-, and ATB- terminals, respectively (SFD-D421, D423). The directory number units digit is always zero.

As an indication of whether the allotted number is distributed over a maximum of 4 or 8 number groups, the 4NG or 8NG relay operates from the ANA- relay (SFD-D423).

To provide for auxiliary contacts for the ANA- relay, the ANB0-9, ANCO, 4, 5, 9 and AND0, 4, 5, 9 relays are provided. They operate when the ANAO-9 relay operates (SFD-D423).

D4-7.3.2 Allotted Number Timing

Sufficient time must be allowed for the operation of the AN and ANA- relays if the called number is in an allotted hunting group.

The allotted start ALS0-5 relay operates the ADVA (allotted number series auxiliary) relay which in turn operates the ANT (allotted number timer) relay (SFD-D407, D420). The operate time interval of these two relays allows enough time for the AN and ANA- relays to operate if the number is allotted. If the called number is in an allotted hunting group, the ANT relay operates the ANS relay.

Failure to operate the AN relay, by the time the allotter timing relay ANT operates, causes the operation of the NANS (nonallotted number series relay). This indicates that the called number, within the number series containing allotted numbers, is not an allotted hunting group. For this condition the start battery for seizure of the NG is extended through the operated ANT relay contacts and nonoperated AN relay contacts (SFD-D408). The NG is then seized in a manner similar to that used when no allotted PBX is provided.

D4-7.3.3 Allotted Number Operation and Busy Test

If the called number is an allotted directory number, the allotter tests to determine which number groups have idle lines, and then causes the CM to select one of these number groups for service. This arrangement saves CM and NG holding time, since the CM causes line busy to be returned

to the calling customer without seizing a NG when all lines of the PBX are busy. The CM is then provided with the thousands, hundreds, tens, and units digit information of the first line of this allotted PBX in the selected number group. To accomplish the seizure of an idle NG after the allotter has determined that the called number is allotted, relay ANS operates the NAR1,2 (no allotter recycle) relays. The NAR2 closes ground to operate the CKO relay. The start battery path through the allotter for seizure of the selected NG is closed when CKR relay operates the PBX1 relay.

The operation of the ANA-, ANB-, ANC-, and AND- relays close the windings of the NGTA-H (number group test) relays to the AN- leads of all number groups of an allotted hunting group. If all the lines in a number group in this allotted PBX are busy, battery is extended from the NG over the AN- lead operating the associated NGTA-H relay (SFD-D421). The operated NGTA-H relay indicates that all the lines are busy by operating the AB relay.

An NGA-NGH terminal is cross-connected to an AN- terminal for each NG with which the allotted number is associated. There is one AN- test lead for each NG. When the marker is arranged to work with nonwire-spring-relay type number groups, there is a maximum of four PBX allotter groups per NG; therefore, four test leads, ANO-3, are extended to the marker. When arranged to work with wire-spring-relay type number groups, five test leads, ANO-4 are extended to the marker. These leads permit a maximum of five PBX allotter groups to be served by one number group.

The PBX allotter selects one of a maximum of 8 line groups, A-H, contained within the allotter group, by the operation of NGSA-H (number group selected) relay (SFD-D422). The ANS relay furnishes a ground to the NGSA-H relays through normal contacts of the line group test relays NGTA-H. The selection of the preferred allotter line group is controlled by the NS1 to A1-H1 cross-connections.

If all lines in all number groups in this allotted PBX are busy, the ground, which otherwise operates one of the NGSA-H relays, is extended to operate the AB (all allotted number busy) relay. The operation of the AB relay indicates that busy tone should be transmitted to the calling customer. The AB relay operated also extends ground over one of the OVFO-9 leads to operate an overflow traffic register.

D4-7.3.4 Listed Directory Number Line Group Selected

If the NGSA relay has operated, the selected NG contains the directory number. For this condition the marker selects and controls the NG in accordance with the dialed number. The marker extends battery over the NG start (STO-9) lead, through the operated TH2/5 relays corresponding to the thousands digit of the dialed number, and through the selected NSSO-5 relay contacts. The number group MP- relay operates after relay PBX1

has operated (SFD-D408, D409). Battery is also extended over the HB0-9 and TB0-9 leads, through the operated HN2/5 and T2/5 relay contacts, respectively. The HB0-9 relay and TB0-9 relay that operate correspond to the hundreds and tens digit of the dialed number. An AN (allotted number) relay is connected in parallel with the TB- relay in the NG for the directory number tens block only. The AN relay operates in parallel with the TB- relay in the NG and extends ground back to the marker over the ANK lead to operate the AHG (allotted hunting group) relay (SFD-D420). With the AHG and NGSA relays operated, battery is extended to the UO lead for the units digit information. The first trial TR1A relay is operated and one or more SA0-9 (sleeve test auxiliary) relays are operated to cause the marker to hunt from 0 to 9 for the first idle line (SFD-D424).

D4-7.3.5 Other than Listed Directory Number Line Group Selected

If an NGSB-H relay operates, the selected NG does not contain the listed directory number. The PBX1 relay closes the start lead corresponding to the thousands digit of the first line in the B-H number groups, to operate the MP- relay in the number group.

The NGSB-H relay and the ANA-, ANB-, ANC-, and AND- relays control the selection of the NG hundreds and tens block relays. Battery is extended over the HB0-9 and TB0-9 leads corresponding to the hundreds digit and tens digit, respectively, of the first line of the hunting group in the B-H number groups. These leads are extended to the NG to control the selection of the NG hundreds block and tens block relays. With the AHG and NGSA nonoperated, battery is extended over the UO lead for the units digit information.

D4-7.3.6 Recycle (SFD-D405)

Conditions that cause recycle are:

- (a) CM fails to find an idle line when hunting in the NG.
- (b) CM finds the chosen line busy when testing the line at the LL. This may occur if another marker selects the line between PBX idle test and line busy test.
- (c) CM finds it necessary to reroute the call to intercept or no-such-number trunk.
- (d) CM finds the selected NG made busy.
- (e) CM finds the LL made busy.
- (f) CM encounters a failure to match.

When the CM encounters a recycle condition the NG is released.

The ANR (allotted number recycle) relay operates the ANR2 relay which in turn releases the operated NGSA-H relay. This causes the release of the thousands, hundreds, tens, and units information.

After the marker has completed this recycle, the ANR1 relay operates and again initiates the selection of a NG containing the allotted PBX by reoperating an NGSA-H relay. The preference for operating the NGSA-H relays is changed by the operation of the ANR2 relay (SFD-D420).

D4-7.3.7 Test Call Functions

The TNA (test number group allotter) relay is operated from the master test control circuit when it is desired to operate the NGTA-H relays for a test call. The TNA relay extends the operating circuit for the NGTA-H relays to the master test control circuit. By the operation of associated keys in the master test control circuit, the NGTA-H relays may be operated for test calls.

D4-7.3.8 Trouble Detecting

- (a) If an allotted hunting group is falsely identified as a nonallotted hunting group, the marker detects this condition while terminal hunting in the first tens block of the NG. Under this condition, the ANS relay in the marker is nonoperated. Since the hunting group is allotted, the NG grounds the ANK lead to operate the AHG relay in the marker. Therefore, with the ANS nonoperated and the AHG operated, the XAH (cross allotted hunting group) relay is operated. The operation of the XAH relay indicates failure for the first trial only. For second trial, this trouble detection feature is canceled by the operation of relay TR2B. This opens the XAH relay operating circuit and results in the completion of the call.

The XAN trouble recorder card indication is punched, but the AN indication is not punched, when this type of failure occurs. This indicates that the call has progressed into or beyond NG seizure.

- (b) The marker is prevented from completing the connection when false allotting of a nonallotted hunting number occurs. This condition is detected while hunting in the first tens block of the NG. For this condition the NGSA relay is operated, but the AHG relay is nonoperated; therefore, the operating path of the units digit relay in the NG is opened, resulting in a marker time-out.

The AN trouble recorder card indication is punched, but the U- indication is not punched. This indicates that the number should not be treated as an allotted number, and that the call has progressed into or beyond NG seizure.

- (c) A crossed allotted number is indicated by the operation of the XAN relay when the ANAO-9, ANBO-9, ANCO, 4, 5, 9 and ANDO, 4, 5, 9, relays, associated with two or more hunting groups, are operated. This prevents seizure of any NG by opening the operate circuit to the NGSK relay and results in a marker time-out. Both the XAN and AN trouble recorder card indications are punched, indicating that the call has not progressed to NG seizure.

When both a nonallotted and allotted number identification is made, the XN relay operates. This produces a trouble record card on which the XN indication is punched.

When more than one number series identification is made, the XNS relay operates. The XNS relay operates the XN relay, which causes a trouble record to be taken. The XN indication is punched.

D4-8 VERIFICATION OF PBX LINES OR OTHER LINES HAVING RC10 CROSS- CONNECTION IN THE NUMBER GROUP (SFD-D426)

The MTC provides means for detecting omitted or transposed sleeve cross-connections on lines having RC10 number group cross-connections.

In order to gain access to both ends of the number group sleeve cross-connection, the marker is directed to complete a connection to the line, but is prevented from operating the line hold magnet. The release of the number group is delayed to allow access to the line end and the number group end of the sleeve at the same time.

The MTC then tests both ends of the sleeve for battery (line idle condition). If both ends of the sleeve have battery, the MTC applies ground to the line hold magnet end of the sleeve and awaits removal or shunting of battery at the number group sleeve. (This may be the direct shunting of the line hold magnet battery or may be controlled through an auxiliary line circuit.)

If battery is removed at the number group end of the sleeve, MTC removes the ground at the line hold magnet end and awaits restoration of a line idle (battery) condition at the number group end.

D4-8.1 SLEEVE CHECK VERIFICATION

When the RC10 key is operated, operation of the LV relay operates the VER6 relay of the MTC to prepare it for verification of the sleeve cross-connection from the line hold magnet to the number group.

The VER6 relay operated, closes leads MT10, MT19, and HTR to signal the marker to extend the S(0-9) leads to the number group, to delay the release of the number group, to open the operate path for the line link frame select magnets, and to handle calls on a heavy traffic basis.

The VER6 relay operates VER7 which extends the S(0-9) lead, corresponding to the units digit of the number being verified, through the operated D(0-9) key or switch by way of the marker to the number group.

When the marker connects to the number group and the S(0-9) lead has been closed to the NS punching corresponding to the number, the NST relay operates if there is battery on the lead. (It should be noted that operation of the NST at this time indicates only that there is battery from some source on the NS punching. It may or may not be associated with the proper line hold magnet.)

When the marker connects to the line link frame, the marker operates the LHM relay which simulates a line hold magnet. The LST relay of the MTC is connected to the actual line hold magnet and, if the line is idle, operates to the line hold magnet battery (provided the NST relay has operated to provide ground to the winding of the LST relay).

If the LST operates, it operates the LI (line idle) relay which grounds the LHM lead, shunts down the LST relay, operates the line hold magnet, and extends ground to the number group sleeve (directly or by way of an auxiliary circuit which causes the battery at the number group sleeve to be shunted or removed). This ground shunts down the NST relay.

With both LST and NST normal, the NS relay operates to remove ground from the LHM lead. The NST relay should reoperate immediately if there is a direct sleeve cross-connection or after a short interval if auxiliary circuits are cross-connected between the line sleeve and the number sleeve. If battery is restored at the number sleeve, NST operates, closing ground to winding of LST which reoperates to battery from the line hold magnet and in turn operates the SLK relay which locks and lights SLK lamp as a sleeve check indication. If a trouble record card is taken, the CMC designation is punched as a sleeve check indication. If the sleeve and all other cross-connections check, the MLVM lamp is lighted and LVM designation is punched.

In order to be able to operate the line hold magnet and check the sleeve independently of tests which the marker makes on the line links, the marker is prevented from operating the line select magnets so that, upon operation of the line hold magnet, no crosspoints are closed.

D4-8.2 SLEEVE CHECK FAILURE

If both the NST and LST relays operate initially and operate the LI relay, indicating an idle line condition, the LI relay starts the SLKT timer to allow an interval of 1.05 to 1.6 seconds for sleeve check verification to allow for operation of certain slow auxiliary circuits.

Upon operation of the DCT relay by the marker, either the MLVM or MLVF relay operates depending on whether all check relays (other than sleeve check) operated or one or more of them is normal.

If MLVM operates, the circuit awaits either operation of the SLK relay indicating sleeve check or the SLKT relay as a result of failure to check within the allowed time interval. In either event, a trouble record is taken only if the REC key is operated. The verification of cross-connections other than sleeve is indicated by the CK lamp, or the CMA punch on the card. The MLVF lamp is lighted and the LVF designation is punched if the sleeve fails to check.

If MLVF operates because of other than a sleeve check failure, an immediate trouble record is produced, the MLVF lamp is lighted, and an LVF designation is punched.

SECTION D, PART 5
CONNECTION TO LINE LINK FRAME

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D5 CONNECTION TO LINE LINK FRAME

The LL (line link) containing the called line is seized to enable the marker control of the desired select and hold magnets. An LL seizure is also necessary whenever a connection to a called line location on a tandem type call is required. This connection is referred to as FLG (call forward linkage). The FLG is used on an INC TER (incoming terminating), TAN (tandem), and IAO (intraoffice) type calls.

D5-1 LINE LINK FRAME SEIZURE (SFD-D502, D504, D505)

On INC TER calls the seizure of the LL is made after the TL (trunk link) and NG (number group) have been selected. If trouble is encountered in the progress of the call, at this point, the CK punch will be an indication that the proper TL selection is made (SFD-D302). The NGK punch indicates the marker has seized the NG and operated its marker cut-in (MCA) relay (SFD-D402). The LFS battery from the CM is applied to the LL-ST lead through the operated LLC2, PTK, RCL, FLG1, FUT-, and FTT-relays in the CM to the ST- lead of the LLC-PC (line link connector preference control) circuit operating the MP- relay and associated LLC multicontact relays. The LFK punch is an indication that all LLC relays have properly operated.

D5-1.1 PREFERENCE CONTROL CIRCUIT (SFD-D505)

The preference control associated with the LLC provides two preference relays, MP- (marker preference) and E- (emergency) marker preference, per marker for each LLC. There is a means for detecting trouble associated with both the MP- and the E- relays and for automatically switching from one to the other in the event of detected trouble. The MP- relays are interconnected by two chain circuits, which enable connections of one marker at a time to an LL frame. Similar independent chains interconnect the E- relays. While the following description is for MP-relays, it applies equally to E- relays.

D5-1.1.1 MP- Relay Operate Chain

In periods of very light traffic, (assuming only one marker at a time applies start battery to bid for seizure of a LL) MP- relay operation is straightforward. Start signal battery from a marker is applied to the associated MP- relay winding which is connected through the MP- operated chain to ground at the winding of the first relay in the operate chain. In periods of heavy traffic two or more markers may initiate request either simultaneously or in rapid succession.

Assume that the first CM and the first DTM initiate simultaneous request (apply start battery) for connection to the same LL. Both MP- relays will operate and lock. If, however, the first DTM had initiated a request slightly before the first CM, the MP- relay for the first CM could not have operated because ground for its winding would have been opened by the operated chain at the MP- relay for the first DTM. On the other hand, if the first CM initiated a bid first, any other marker ahead of it in the operate chain can subsequently operate its MP- relay.

D5-1.1.2 MP- Relay Work Chain

Since it is possible to operate two or more MP- relays at the same time, a work chain determines which MP- relay does the work. The work chain progresses through contacts of the MP- relays in the opposite direction to the operate chain starting with ground at a contact of the MP- relay for the first CM. If the MP- relay for the first CM is operated, the work chain ground will operate the M- LLC relay whether or not other MP- relays are operated. The M- relay operates other M- relays in the connector by closing through battery supplied by the marker.

When the marker which has seized the LL has finished its work and opened the start lead to the PC, its MP- relay is released. If there are any other operated MP- relays, the next MP- relay in the work chain which is operated, now functions as just described. This continues until all operated MP- relays have been served.

D5-1.1.3 Emergency Transfer

Two sets of preference relays (MP- and E-) are provided in the preference control, either of which can perform the preference job while the other serves as a standby. The CH relay provides trouble detection on the active set of preference relays by monitoring the operate chain and one of the work chains. Assume that the TR key and TR- relays are normal so that MP- relays are active. When all MP- relays are normal, ground through all break contacts of the operate chain is connected to one side of the CH relay winding, and ground through all break contacts of the work chain which operated connector relays is connected to the other. The CH relay cannot operate with ground on both sides of its winding. When one or more of the MP- relays operate, both preference chains are opened to remove ground from both sides of the CH relay winding leaving resistance battery connected to both sides of the winding. Again the relay cannot operate. If, however, all break contacts of either chain do not conduct, or if a wire is broken when the MP- relays are normal, one side of the CH relay winding will have ground and the other side will have resistance battery which will operate the CH relay. Also, if any of the break contacts fail to open or if there is a false ground on either chain when one or more MP- relays operate, the CH relay will again have resistance battery on one side of its winding and ground on the other side and will operate.

If the CH relay operates even momentarily, the TR relay operates and locks. The TR relay operates TR- relays which transfer the SF, CK-, and MC- leads from the MP- relays to E- relays. The TR relay also brings in a minor alarm and lights a CH lamp.

The alarm can be restored by momentarily operating the AR key located at the frame or can be restored remotely via the alarm sending circuit. Release of the alarm also restores operation to the MP- chain if the TR key is normal or to the E- chain if the TR key is operated.

D5-1.1.4 Manual Transfer

By operating the TR key, the preference control can be manually transferred for the MP- to the E- relays. The TR key operates the TR- relays which remain operated to accomplish the transfer as described previously. The TR key also connects the CH relay to chains of the E- relays. If the CH relay operates, it operates the TR relay which locks and releases the TR- relays to transfer preference back to the MP- relays.

D5-2 LINE LINK FRAME CONTROL NONPAIRED OPERATION (SFD-D507)

The marker obtains access to the LL frame through the preference control and make-busy circuit and LLC circuit.

On an FLG linkage, a translation is necessary from the number group to translate the called customers number into the line location on the LL. This location is registered on the FTT-, FUT-, VGT-, HGT-, and VFT-relays in the marker as shown on SFD-D417.

With the seizure of the TL and the information received from the NG the marker can now close battery to the ST- lead to seize the LLC (SFD-D504, D505). The FTT-, and FUT- relays determine the LL and the VGT-, HGT-, and VFT relays determine the customers line location on a particular switch.

The marker will place HGB resistance battery on the HG- lead corresponding to the horizontal group number which it obtained from the NG. The operation of the MA1 relay in the LLC will extend the HG- lead to operate the HGA- and HGB- relays in the LL (SFD-D507).

The marker will place VGB resistance battery on the VGB- lead corresponding to the vertical group number which it obtained from the NG. The operation of the MA1 relay in the LLC will extend the VGB- lead to operate the VGB- relay in the LL (SFD-D507).

With the HGA-, HGB-, and VGB relays operated, a path is closed from the LG- relay to the BS lead. However, the BS lead does not have battery connected to it by the marker until the marker receives ground on the

HGK lead. The purpose of this is to insure closing the operating current of the LG- relay in the marker rather than through the HGA-, HGB-, or VGB- relay contacts so that protection can be provided on the basis of one per frame instead of one per LG- relay. The VGB- relay will operate before the closure of lead BS occurs.

D5-2.1 CROSS DETECTION (SFD-D507)

The marker employs the operate test to detect trouble on the HGA-, HGB-, LG-, or VGB- relays in the LL. If, for some reason, more than one HGA- or HGB- relay operated in the LL, the XHG relay would operate in the marker. This condition would stop progress of the call. The HGK punch would not be present on a trouble card.

If, for some reason, more than one LG- relay operated in the LL the XLG relay would operate in the marker. The operation of the XLG relay would produce the XLG trouble punch.

If, for some reason, more than one VGB- relay operated in the LL the XVGB relay would operate in the marker. The operation of the XVGB relay would extend ground to operate the XAVG relay in the marker and produce the XVGB trouble punch.

D5-3 PAIRED LINE LINK FRAMES

Paired line link operation is possible on all types of linkage except dial tone. Before paired line link operation can be applied to a marker group, the junctor groups must be wired as one of the following sizes, 60LL-30TL, 40LL-20TL, 20LL-10TL.

An auxiliary LL frame consists primarily of ten 200 point crossbar switches split into the right and left halves. The verticals of the right half are multiplied to the junctor switch verticals of the even numbered line link frame while the horizontals serving these verticals become an extension of the line links of the odd LL frames. A similar transposed appearance of even frame links and odd frame junctors exist on the left half. In effect, linkage is provided from the line switches of one line link frame to the junctors of its mate.

D5-3.1 PAIRED LL FRAME AUXILIARY LL FRAME IDENTIFICATION (SFD-D508)

In a particular office, the marker recognizes a paired line link frame by the presence of solid ground on the LFK lead when the associated line link connector is operated. This ground operates the marginal PRL and LFKA relays. The LFKA in turn operates the LFK relay. A nonpaired LL

frame will have resistance ground on its LFK lead, in which case only the LFKA relay operates. Relay LFKA operated operates the LFK relay and marker operation continues.

Relay PRL operated operates PRL relay and also operates the PRLA relay (if provided). These relays have no effect until a channel test is made. With 10TLF relay operated, and no channels available, the operate path for the FMP relay is diverted by the PRL relay to the STP relay. Relay STP operated, with the sequential release of GC relay and operation of STP3 relay, initiates the junctor step. Subsequently, STP1 relay releases and relay STP2 operates. Relay JG0 releases and JG1 relay operates.

D5-3.2 PAIRED LL FRAME MATE SEIZURE (SFD-D508)

Relay STP3 operated (with PRL relay operated and MFK relay normal) operates the STPA relay. Relay STPA operated locks around the contact of MFK relay, and places resistance battery on the MPP lead toward the LLC. This MPP lead connects to the MPP relay in the line link preference control circuit of the mate LL frame.

Relay MPP operated has two functions:

- (1) It closes its contact in the work preference control circuit in order to seize the auxiliary LL frame when preference is gained.
- (2) It closes solid ground toward the LLC for the LL frame associated with that preference control circuit. If this particular LL frame should have its connector closed to some other marker, solid ground on the MFK lead will operate the MFK and MFL relays in that marker, opening the operate path for the STPA relay and preventing that marker from attempting mate operation.

When preference is gained in the mate LL frame preference control circuit, the auxiliary LL frame associated with this pair of LL frames is seized. Relays operate in this frame to cut through the select magnet leads from the LL frame to the select magnets of the auxiliary frame junctor switches. The choice of select magnets will be controlled by the horizontal group relays in the LL frame, and will correspond to those select magnets which are chosen on the LL frame junctor switch.

Seizure of the auxiliary LL frame will transmit resistance ground on the MFK lead through the connector to the marker. Relay MFK alone operates and with STPA relay operated, completes the operate path for the TK relay.

During this time the STP2 and JG1 relays, in combination with the PRL and PRLA relays operated, have selected the opposite half of the trunk switch, and reoperated those relays, such as the PNR (pattern normal)

relay, in the junctor step and control circuits in preparation for channel test. With the operation of the TK relay, channel test is again made.

D5-3.3 PAIRED LL FRAME AUXILIARY LL CONTROL (SFD-D509)

When the MPP relay operates, it places ground on the LV lead to the auxiliary LL frame, through the operated HGB- relays of the LL frame. This ground will operate a LV- relay and a EV or OD- relay in the auxiliary LL frame. The numerical designation of the LV- relay operated will be the same as the HG- relay operated in the LL.

The operation of the LV- relay and the EV or ODD relay will parallel the select magnets on the auxiliary LL frame with the select magnets on the original LL frame. The operation of the EV or ODD relay will close a resistance ground to the marker over the MFK lead as an indication of mate frame lockout and select magnet cut-through.

D5-4 PAIRED LINE LINK FRAME - MARKER GLARE CONDITION (SFD-D508)

There is a possibility that two markers could have simultaneous calls to mated LL frames. As described previously, the marker expects a resistance ground on the MFK lead as an indication that the MPP relay has the work preference in the preference control circuit. If there is another marker in the mate LL frame also attempting a mate frame lockout, both markers would receive direct rather than resistance ground on the MFK lead. Both markers would recognize direct ground on the MFK lead as a glare condition and set the trunk to overflow.

D5-5 PAIRED LL FRAME AUXILIARY LL - MAKE BUSY (SFD-D508)

The auxiliary LL frame is made busy by inserting make-busy plugs into both the MBO and MBE jacks. A make-busy plug in either the MBO or MBE jack will indicate to the marker, when it is attached to the LLC, that the LL is nonpaired rather than paired.

D5-6 CLASS OF SERVICE (SFD-D502, D510, D511)

Class of service progress information for incoming terminating class of calls is shown on SFD-D502, D510, and D511. Although class of service is not required by the CM for controlling the INC call, the class of service is required to control dual voltage operation to operate the line hold magnets. Dual voltage is the application of 178 volts to the hold magnets.

Dual voltage operation of line hold magnets equipped for message register service may cause false operation of the message register. Accordingly the marker must operate all line hold magnets used with lines that are equipped with message registers, using only 48 volts.

Lines equipped with message registers are indicated to the marker over the class of service leads from the LL. The class of service indication is received over the CS00-29 leads which in turn are cross-connected to operate the CNA (coin line auxiliary), MRA (message register auxiliary), or AOA (all other auxiliary) relays. The operation of CNA or AOA relays operates the DVO relay which in turn operates the DVA relay indicating that the marker should use dual voltage to operate the line hold magnet. The operation of the MRA indicates 48 volts operation for the line hold magnet.

For more detailed information of 20, 30, 60, and 100 classes of service see SFD Section C or E.

SECTION D, PART 6

CHANNEL SELECTION, HOLD MAGNET OPERATION
AND RINGING SELECTION SWITCH CONTROL

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D6 NETWORK CONNECTIONS

Connections between a line and a trunk are made by closing the line switch and junctor switch crosspoints on the LL (line link), and the junctor switch and trunk switch crosspoints on the TL (trunk link). The select magnets and hold magnets involved in closing the specific crosspoints depend on the location of the line on the line switch, the trunk on the trunk switch, and on the channel selected.

Following hold magnet operation, the channel is checked for crosses, continuity, and double connections. The NG (number group) is released and the ringing switch crosspoints are operated (SFD-D602, D603).

D6-1 CHANNEL ARRANGEMENTS

A channel is made up of a line link, a junctor and a trunk link, which are tested, selected and treated as a unit when establishing a connection between a line and a trunk or between two trunks.

The line links consist of the line switch banjo wiring, the line junctor switch banjo wiring, and the wiring between these switches.

The trunk links consist of the trunk switch vertical unit, the trunk junctor switch vertical unit, and the wiring between the two switches.

The juncctors consist of the line junctor switch vertical unit, the trunk junctor switch banjo wiring, and the wiring between the line junctor and trunk junctor switches.

The marker in selecting a channel, tests a maximum of ten channels at a time. The CHT- (channel test) relay tests a line link, a junctor, and a trunk link with numbers corresponding to the CHT- relay numbers. These tests are made simultaneously. Ground on any of the test leads operates a CHT- relay to indicate a busy channel. The channel number corresponds to the junctor switch number 0-9 on both the LL and the TL, the horizontal level 0-9 on the LL line switch, and the vertical number of the trunk switch on the TL.

D6-1.1 JUNCTOR SEQUENCE CONTROL (SFD-D606,D607)

The number of juncctors in a junctor group may vary from a maximum of fifty juncctors to a minimum of ten juncctors. Since the marker is equipped to simultaneously test a maximum of ten channels and, therefore, to test a maximum of ten juncctors, each junctor group is subdivided into junctor subgroups consisting of ten or less juncctors. The marker selects those juncctors within one junctor subgroup when testing for an idle channel. The selection of the subgroup of ten or less juncctors is, in general, determined by the following factors:

- (a) The number of TLs in the marker group as indicated by the 2-10 TLF relays.
- (b) The LL number.
- (c) The junctor sequence position JSQ 0-5 which is used to equalize and rotate the traffic among the subgroups.
- (d) The junctor step STP1/2 position.

The selected subgroup of junctors is assigned to the ten channels so that the numerical designation of the junctor switch on both the LL and the TL to which the junctor connects is also the numerical designation of the channel of which the junctor is a part.

The junctor sequence walking circuit is shown on SFD-D607. A sequence chart showing the advance of the walking circuit on successive calls is shown on SFD-D606.

In the beginning of the call when the CKG4 relay operates, CKG4 in turn operates the LLC1,2 (Line Link Control) relays. If the sequence circuit is in an even position (JSQ0,2 or 4 and JLO operated), the LLC2 relay operates the JSQ relay which locks. When the LLC2 relay releases at the end of the call, the next higher numbered odd JSQ- relay operates, and, in turn, operates the JLE relay. The JLE relay releases the JSQ-, JLO and JSQ relays. Similar operation occurs when stepping from an odd to an even JSQ relay.

Six steps of control for preference circuits are provided by the JSQ 0-5 relays. This number is doubled by the operation of the SQ0 and SQ1 relays. If the SQ1 relay is normal when the JSQ0 relay operates, the SQ0 relay operates. If the SQ1 relay is operated when the JSQ0 relay operates, the SQ0 relay releases. Similarly, the SQ1 relay is operated or released depending on the condition of the SQ0 relay when the JSQ2 relay operates. The SQ0 relay is operated for one complete cycle of the walking circuit, then released for one complete cycle. The same applies to the SQ1 relay. However, since the SQ0 is operated and released by JSQ0, and SQ1 is operated and released by JSQ2, there are steps during which SQ0 and SQ1 may both be operated or both released.

The SQA relay monitors operations of the junctor sequence walking circuit. If the SQA relay operates as a result of trouble in the walking circuit, it operates the MXT (master cross test) relay which causes a trouble record to be produced showing an SQA trouble punch.

The following conditions cause operation of the SQA relay which is a slow operate relay to prevent false operation due to momentary closures as relays change conditions. The SQA relay operates the MXT relay which operates the TR1 relay to cause a trouble record to be taken showing an MXT and an SQA punch. The MXT is not shown on a single-sided card.

Trouble conditions detected between calls (LLC2-normal) occur when:

- (a) Both JLE and JLO are normal
- (b) Both JLO and JSO are operated
- (c) Both JLE and JSE are operated

Trouble conditions detected during calls (LLC2 operated) occur when:

- (a) JLO is operated and JSO is normal
- (b) JLE is operated and JSE is normal
- (c) SQ0 and SQ1 are both operated or both are normal when JSQ1 is operated
- (d) SQ0 is operated and SQ1 is normal or SQ0 is normal and SQ1 is operated when JSQ1 is operated

When the fuse which supplies battery to the walking circuit is inserted, the SQA relay will operate because the JLE and JLO relays are both normal. When the SQA relay operates, it operates the JSQ0 relay which operates the JLO relay which should release the SQA relay if there is no trouble in the walking circuit. This will cause a trouble record to be taken which will show an MXT punch, but no SQA punch unless the SQA remains operated because of trouble. The MXT is not shown on a single-sided card.

D6-1.1.1 Control of Junctor Sequence by Master Test Control
(SFD-D607)

With one of the JSQ0-5 keys or switches operated and the KCH relay operated, the MT8 relay of the marker is operated after the master test frame connector has operated the MT relay of the marker. The MT8 relay of the marker operated, releases the operated JSQ0-5 relay of the marker by opening its locking circuit. The released JSQ- relay releases the JLE or JLO relay of the marker and the released JLE or JLO in turn operates the KJSQ relay. The KJSQ relay closes ground from a back contact of the MT8K relay through the operated JSQ0-5 key or switch to operate the corresponding JSQ0-5 relay of the marker. This operates the JLE or JLO relay of the marker which removes ground from the KJSQ lead to release the MT8 relay of the marker whose operate path has been transferred to the KJSQ lead by the KJSQ relay of the test circuit when it operated and locked to ground on the KCH relay operated. The MT8 relay normal, closes the MT8K lead to operate the MT8K relay of the test circuit. The MT8K relay operated, locks to the KCH relay, removes ground from the JSQ0-5 lead, and extends ground to operate the MC relay. With all JSQ0-5 keys normal or the switch in the off position, or with the KCH relay normal the junctor sequence relays of the marker function in a normal manner.

If no JSQ0-5 key or switch is operated, the MTF lead to the marker is open and the MT8K lead is closed to the MC relay through normal contacts of the JSQ0-5 key or switch. The KCH relay normal bridges the MT8K lead around contacts of the JSQ0-5 keys or switches.

D6-1.2 OFFICE SIZE TRUNK LINK FRAMES (SFD-D607)

A cross-connection in each CM from the SZD terminal to one of the terminals SZ2-10 indicates the size of the office in terms of the number of single trunk link frames in a nonpaired office, number of pairs of trunk link frames in a paired office, or number of trunk link frame triples in a triple office.

During transition from one size office to another, some trunk link frames may have a junctor pattern for one size office while others have a different size office junctor pattern. In this case, the SZA, SZB and SZC terminals are cross-connected to appropriate SZ2-10 terminals in each marker, and the G terminal of each trunk link frame is cross-connected to SZA, SZB or SZC terminals as required. These cross-connections are changed in individual trunk link frames as the transition progresses. Upon completion of the transition, the SZD terminal of each CM is cross-connected to the SZ2-10 terminal corresponding to the new office size.

D6-1.3 SINGLE PAIRED OR TRIPLE TRUNK LINK FRAME OPERATION (SFD-D610)

A cross-connection in each CM from the SPF terminal to the SF, PR, or TTF terminal indicates to the CM whether the office is arranged for single, paired, or triple trunk link frame operation. During transitions, however, from single to paired, or paired to triple-trunk link frame operation, the marker cross-connections are removed and cross-connections are made in each TLC. A frame which has not been modified might be cross-connected as a STF (single trunk link frame) while another frame which has been modified might be cross-connected as a PR (paired trunk link frame).

D6-1.4 OFFICE SIZE LINE LINK FRAMES (SFD-D610)

The marker determines office size in terms of number of line link frames from a combination of the office size in terms of trunk link frames (SCD-D6-1.2) and the indication of single, paired, or triple trunk link frame operation (SCD-D6-1.3). The 20F relay operates for 1-20 line link frames, the 40F relay for 21-40 line link frames and the 60F relay for 41-60 line link frames.

D6-1.5 PATTERN UNITS (SFD-D604)

In the following size offices all junctor subgroups have 10 junctors.

2TLF Single, paired or triple.
2-3TLF Single, paired or triple.
5TLF Single, paired or triple.
10TLF Single, paired or triple.

All other sizes have some junctor subgroups with less than 10 junctors.

To determine which junctors are equipped, one P0-9 (pattern unit) relay is operated in the CM. The SFD-D604 shows how a particular pattern unit relay is operated for TLO in an office having single TL operation. It also shows particular pattern unit relay operation for either TL of TL pair 0 in an office having paired TL operation. Also shown is a particular pattern unit relay operation for any TL of TL triple 0 in an office having triple TL operation. The choice of a pattern unit relay is determined by the line link frame number (FUTO-9 relay and FTB0-3 relay operated) and the line link office size relay 20F, 40F, or 60F operated.

D6-1.6 NUMBER OF JUNCTOR SUBGROUPS (SFD-D608,D609)

This applies only to 6 TLF and 7 TLF size offices. Both of these office sizes have some junctor groups with two, and other junctor groups with three junctor subgroups. With either relay 6 TLF or 7 TLF operated, relays P0, 2, 3 and 4 operate the 3G (3 junctor subgroup) relay while relays P4-9 operate the 2G (2 junctor subgroup) relay.

D6-1.7 QUAD RELAYS (SFD-D610)

The 7Q (seven quad) relay is used only in paired or triple trunk link frame offices of the 7 TLF size. The RQ (regular quad) relay is used only in paired or triple trunk link frame offices of 6TLF, 8TLF or 9TLF sizes. The term "quad" no longer has a valid meaning since triple trunk link frame operation came into use. Essentially, these relays provide a convenient and more economical method of steering the JC- leads (SFD-D613) than by using contacts of TLF for a particular size offices.

D6-1.8 PATTERN TENS (SFD-D605)

The PNR relay is always operated by the following office sizes which have no subgroups of less than 10 junctors.

2TLF Single, paired or triple
2-3TLF Single, paired or triple

5TLF Single, paired or triple

10TLF Single, paired or triple

The PNR relay is also operated for certain other office sizes when the marker is directed by the operated or released condition of the STP1, STP2, and JSQ relays to junctor subgroups having 10 junctors. When the marker is directed to subgroups having less than 10 junctors, one of the pattern tens relays PA, PB, PC, or PE is operated.

D6-1.9 TEST CHANNEL RELAYS - TEST CHANNEL CHECK (SFD-D614,D617)

The marker determines which channels are equipped in a subgroup by operating one, two, etc. or all TCH-9 relays (SFD-D614). The PNR relay operates all ten TCH- relays. The combination of one pattern tens and one pattern units relay operates only those TCH- relays corresponding to equipped junctors.

The operation of any TCH relay operates the TCHK relay (SFD-D617) which locks to the operated CHA relay.

D6-1.10 JUNCTOR SUBGROUP SELECTION (SFD-D608,D609)

To simplify the path for operation of the JG relays, SFD-D608 shows operate paths for offices with 2, 2-3, 5, or 10 TLF-size while SFD-D609 shows operate paths for all other sizes 3, 4, 6, 7, 8, and 9. Note on SFD-D608 that only the JG0 relay can be operated for the 10TLF size since there is never more than one junctor subgroup. For the 5TLF size either JG0 or JG1 relay may be operated. For the 2-3TLF size, JG0 or JG3 relays may be operated. For the 2TLF size, JG0-JG4 relays may be operated. Since no pattern units relay is required for these office sizes, the 1-out-of-10 check of the P- relay is bypassed.

Office sizes 3, 4, 6, 7, 8, and 9TLF each have one or more junctor subgroups with less than 10 junctors and, therefore, must operate a pattern unit relay. Ground for operating the JG-relays is provided through a 1-out-of-10 check of pattern unit relays, and if the office has triple trunk link frames, a similar check through pattern auxiliary relays.

For any size office, the STP1 relay (SFD-D617) is always operated at the beginning of a call. If no idle channel is available in the junctor subgroup selected through the STP1 relay, the STP1 relay will be released and the STP2 relay operated to operate a different junctor subgroup, JG- relay. This applies to all sizes except 10TLF which has only one junctor subgroup.

The walking circuit is stepped to a new position at the end of each call for office sizes having more than one junctor subgroup. Different subgroups are given preference according to which JSQ0-5 and JLE or JLO relays are operated.

D6-1.11 JUNCTOR SUBGROUP CONNECTOR RELAYS (SFD-D617, D610)

The GC or GCA relay in some cases with triple trunk link frame operation (SFD-D617) operates early in the call from the LLC1 relay. The operated GC or GCA relay steers battery through contacts of an operated JG0-4 relay to operate a junctor subgroup connect relay G0-4 in the trunk link connector (SFD-D610). A one-out-of-five check through the JG0-4 relay ensures that only one relay is operated. To detect crossed G-leads to the TLC, normal JG- relays ground associated leads. If the lead associated with the operated JG- relay is crossed to any other lead, the direct ground causes sufficient current to flow through the XJG relay to operate it. The XJG relay is biased to not operate on the current required to operate the G- relay in the TLC. If the XJG relay operates, it in turn operates the XAJG relay which locks and causes a trouble record showing XJG punch to be taken.

D6-1.12 JUNCTOR CONNECT RELAYS - JUNCTOR CONNECT CHECK (SFD-D613, D619)

Junctor connect relays JC0-9 are associated with regular trunk junctor switches. Relays JC10-19 are associated with extension trunk junctor switches. Relays JC20-29 are associated with supplementary trunk junctor switches. The JC0-9 leads are partially closed by the previously operated G0-4 relays in the TLC.

The path for operating the JC- relays is shown on SFD-D613. Battery is supplied through the primary winding of the XJC relay so that the XJC relay is connected to ground through more than one JC relay winding. The XJC relay is biased through its secondary winding. If more than two JC leads are crossed or grounded, the current through the primary winding is sufficient to overcome the bias of the secondary and operate the XJC relay. When the XJC relay operates, it operates the XAJC relay which causes a trouble record showing a XJC punch.

When the G0 relay in the TLC is operated, JC0-9 leads from the marker are closed through directly to the JC0-9 leads, respectively, to the TL. However, relays G1-G4 close the JC0-9 leads from the marker to cross-connection terminals G10-19, G20-29, G30-39, and G40-49. The cross-connections required are different for each office size and vary between TLC associated with different TL in the same office.

To steer the activated JC lead to the proper JC0-9, JC10-19, or JC20-29 relays, the marker operates an RF, EF, or SEF relay (regular, extension, or supplementary extension frame, SFD-D612). Battery to operate one of these relays is fed through the winding of the XF relay which is biased to operate if the RF, EF, or SEF leads are grounded or crossed so that the XF relay supplies current to more than one relay. If the XF relay operates, it operates the XAF relay which causes a trouble record showing an XF punch.

The JC0 relay (SFD-D621) connects to the sleeve leads of the level 0 junctors on the left and the level 0 junctors on the right of each of the junctor switches 0-9. The JC0 relay also connects to ten different level 0 select magnets, one on each junctor switch 0-9. Similarly, each of the JC1-9 relays connect to sleeve leads and select magnets associated with levels 1-9, respectively, on each of the junctor switches 0-9. To associate with the junctors located on the right or left half of the switches, a marker operates R, ER, and SER relays or L, EL, and SEL relays (SFD-D612). The ER and EL relays (extension right and left) are required only for paired and tripled TL operation. The SER and SEL relays (supplementary extension right and left) are required only for triple TL frame operation. The battery to operate these relays is fed through the winding of the XLR relay. The XLR relay is biased to operate when connected to more than one relay, either L or R when the STF relay is operated for single TL frame offices. It is biased to operate when connected to more than three relays (R, ER, and SER, or L, EL, and SEL) when the STF and PR relays are normal in triple trunk link frame offices. It should be noted (SFD-D610) that during transitions STF or PR may be operated or nonoperated depending on which TLC is used. A TLC which has not been changed over from single to paired operation would still operate the STF relay while a TLC which had been modified would operate the PR relay.

When a JC relay operates, the JCK relay (SFD-D619) on the JS0 lead operates to ground through one of the select magnets on the 0 junctor switch as a check that the JC relay has operated. The JCK winding resistance, and JCK series resistance, limit current so that although the sensitive JCK relay operates, the select magnet does not operate.

When R, ER, and SER or L, EL, and SEL operate, the RK or LK (right check or left check SFD-D612) relay operates through contacts of all three relays in series as a check to the marker that they have operated.

D6-1.13 CONNECTION TO LINKS OF HORIZONTAL GROUP ON LINE LINK FRAME (SFD-D507,D616)

Operation of the HGA, HGB relays of the LL frame are shown on SFD-D507. Operation of these relays is checked by operation of the HGK relay of the CM. The operated HGB relay closes through LLO-9 leads to each of the ten links associated with that horizontal group (SFD-D616).

The selected group of ten line links is assigned to ten channels so that the numerical designation of the channel is identical with the numerical designation of the line link test lead LLO-9. The designation also agrees with the numerical designation of the junctor switch and the horizontal level of the line switch which are connected by the line link.

D6-1.14 CONNECTION TO LINKS OF TRUNK SWITCH ON TRUNK LINK FRAME
(SFD-D306,D621)

The selected trunk F relay controls the operation of the FA or FB relay in the TL (SFD-D306). Operation of the FA or FB operates the proper LV2-9 (level connector) and LC0-9 (link connector) relays in the TL for marker control of the select magnet operation, channel test, and hold magnet operation (SFD-D621). The A or B appearance and the horizontal level of the trunk switch is checked by the operation of the FAK or FBK relay in the marker (SFD-D307). To check that the LC relay operated, the LCK relay in the marker operates. The operated LC relay connects to sleeve leads of the links associated with the trunk switch on which the trunks appear (SFD-D621). The operated L or R relay closes through ten sleeve leads associated with the left or right half of the trunk switch (SFD-D621).

The selected group of ten trunk links are assigned to the channels so that the numerical designations of the channel of which the trunk link is a part is identical with the numerical designation of the trunk link test lead LH0-9, and with the numerical designation of the TL junctor switch to which the trunk link connects.

D6-1.15 CHANNEL TEST (SFD-D616)

Ten channel test relays CHT0-9 are connected through diodes to ten line link sleeves, ten junctor sleeves and ten trunk link sleeves (SFD-D616). Diodes in each lead prevent a ground on one leg of a channel such as a line link feeding through to another leg of the channel such as the junctor or trunk link while at the same time permitting a ground on the sleeve of any of the three legs to operate the associated CHT relay. The test paths for the 0 channel are shown in red on SFD-D616. The STX relay (SFD-D115) operates early in the call and provides direct battery to the CHT relay windings. Between calls the STX relay is released. If any of the channel test leads are falsely grounded to either the line or trunk link connectors, the XCH relay will operate between calls. The XCH relay operates the XACH relay which locks and causes a trouble record showing an XCH punch.

D6-1.16 TEST CHECK (SFD-D617)

The preceding paragraphs have described a number of operations which proceed at the same time in preparation for selection of a channel. Upon successful completion of each operation, a check relay operates. These check relays are summarized below.

TCHK - Checks that at least one TCH relay has operated.

JCK - Checks that a JC relay in the TL has operated.

RK/LK - Checks that a R or L relay in the TL has operated.

FAK/FBK - Checks that a FA/FB relay and an LV relay in the TL has operated.

LCK - Checks that a LC relay in the TL has operated.

HGK - Checks that a HGA and HGB relay in the LL has operated.

TCKK - Checks that terminating class of service relays have operated.

When all of the above relays have operated, ground from the operated JCK relay operates the TK (test check) relay.

D6-1.17 SELECTION OF A CHANNEL (SFD-D617)

The LLC1, CHT and SLRK relays will have operated early in the call. With the LLC1 relay operated, ground is closed to operate a CH0-9 relay. There is a double chain path composed of CHT0-9 relays and TCH0-9 relays to determine which CH0-9 relay, if any, is to be operated. Some or all of the TCH- relays (SFD-D614) will be operated as an indication of which channels are provided in the subgroup being tested. Any channel which is busy (SFD-D616) will have an operated CHT relay. If the TCH0 relay is operated and the CHT0 relay is normal, the CH0 relay operates and locks. If, however, either TCH0 relay is normal or CHT0 relay is operated, ground is passed to operate the next relay in the chain which has an operated TCH relay and a normal CHT- relay. When one CH- relay has operated and all others are normal, the CHA relay operates as an indication that a channel has been selected.

D6-1.18 NO IDLE CHANNEL (SFD-D617, D615)

If there is no idle channel, that is, no CH- relay having both an operated TCH- relay and a normal CHT- relay (SFD-D617), the FMP relay operates in a 10 TLF size office. In all other size offices, the STP relay operates. The FMP relay operates the FM relay in turn operating and controlling the operation of two sets of counting relays. One set of counters (1F, 1FA, 2F, 2FA) counts the total failures to match. The RF and RFA counters counts the matching failures within a route. On a first failure to match, RF relay operated, the marker sets the trunk to overflow on TER type calls.

D6-1.19 CONTROL OF CHANNEL SELECTION BY MASTER TEST CONTROL (SFD-D614, D615)

The marker can be directed to select a particular channel under control of the CH0-9 keys or switch, and to select a particular junctor step position under control of the STP1/STP2 key.

D6-1.19.1 Particular Channel Selection (SFD-D614, D615)

With the CH- keys or switch and the STP1/STP2 keys normal, there is no control of channel selection from the master test control circuit and a channel is selected at random as on a service call. With the CH- keys or switch operated, the MT7 relay in the marker operates. This opens the grounds normally used by the marker to operate TCH0-9 relays. The operated CH-key or switch provides ground on one of the TCH0-9 leads to permit the corresponding TCH0-9 relay to operate but only if it would normally have been operated by the combination of pattern relays operated. This procedure restricts the marker so that it can operate only a channel relay corresponding to the operated CH- key or switch. The CH- relay can be operated only if the channel is idle (as indicated by the corresponding CHT- relay normal).

If a particular channel is not available in STP1, the marker makes a retest to try to find a channel in STP2 (except in 10TLF, 20TLF and 30TLF size office) (SFD-D615). Again the marker is restricted to select only the channel corresponding to the operated CH- key or switch.

D6-1.19.2 Combined Particular Junctor Step and Channel Selection (SFD-D614)

When a STP1 or STP2 key and a CH- key or switch are operated together, the CM is restricted to selection of a particular channel within a particular junctor step. The MT7 relay of the CM remains operated in both Step 1 and Step 2. The STP relay of the MTC is operated during Step 1 with the STP1 key operated and during Step 2 with the STP2 key operated. This feeds ground through the operated CH- keys or switch to permit selection of only that channel corresponding to the operated CH- key or switch.

D6-2 SELECT MAGNET OPERATION

D6-2.1 LINE LINK FRAME SELECT MAGNET OPERATION (SFD-D618)

Upon operation of a CH- relay, battery through the LS and LSA resistance lamps is closed to the select magnets on the line link frame. This battery is steered by the operated HGA- relay to the proper link select magnets and junctor hold magnets. It should be remembered that the line junctor switches also serve as line switches. One-half of the verticals is for junctors and the other half is for lines. If the CHO and HGA0 relays are operated for a line on one of the number 0 line switches to a junctor on the 0 junctor switch, an L0 and an LJ0 select magnet are operated. The LJ0 select magnet would serve a customer on the line side of the line junctor switch. If the CH1 relay and HGA0 relays are operated for a line on one of the number 1 line switches to a junctor on the

0 junctor switch, the LJ1 select magnet for the 0 junctor switch would operate, but the LJ0 select magnet on the number 1 junctor switch would also be operated to serve a line on the line side of the number 1 junctor switch.

When paired LL frame operation is provided, the select magnet leads extend to the auxiliary LL frame. The XLS relay is connected to SM- leads through normal contacts of all but the operated CH- relay. If the SM- lead through the operated CH- relay is crossed to any of the other SM- leads, the XLS relay will operate to the applied battery and lock. The XLS relay operates the MXT relay which causes a trouble record to be taken showing an XLS punch.

D6-2.2 TRUNK LINK FRAME JUNCTOR SELECT MAGNET OPERATION (SFD-D619)

Upon operation of a CH- relay, battery is closed to junctor select magnets on the TL. The operated CH- relay closes an JS- lead to a junctor switch of the same number as the CH- relay. An operated JC- relay on the TL closes the JS- lead to a select magnet of the same number as the last digit of the JC- relay. The JC0-9 relays are associated with the regular TL. The JC10-19 relays are associated with the extension TL, and JC20-29 are associated with the supplementary extension TL.

It should be noted that the JCK relay, which operated as a check that a JC- relay has operated, is released if the CHO relay operates to apply battery to the JS0 lead. For this reason, the JCK punch will not appear on trouble cards where channel 0 is shown.

Battery to the JS- leads is fed through the XJS relay which is biased to operate if it is connected to ground through more than one select magnet. If the XJS relay operates, it operates the XAJJS relay. The XAJJS relay operates the MXT relay which causes a trouble record to be taken showing an XJS punch.

D6-2.3 TRUNK LINK FRAME TRUNK SELECT MAGNET OPERATION (SFD-D619)

When the FAK or FBK relay in the marker operates, the battery is extended to the TL on the ASM or BSM lead. This battery is directed by the operated LV- and FA- or FB- relays in the TL to operate a select magnet on the A or B trunk switch steering level and on the level of the selected trunk. Ground for the trunk level select magnets is provided by the marker on the TSX lead. This ground is present upon the release of TSE1 relay immediately following the selection of an idle trunk.

After trunk selection, when the TSE1 relay has released and the FAK or FBK relay has operated, the XTS relay is connected to the TSX lead. The XTS relay is biased to operate if it is connected to battery through more than one T2-9 select magnet. If there is a cross which closes the ASM lead to more than one of the select magnets T2-9, the XTS relay operates and in turn operates the XATS relay which operates the MXT relay to cause a trouble record showing an XTS punch.

D6-3 HOLD MAGNET OPERATION-NETWORK AND LINE TEST

The sequence of hold magnet operation differs, depending on whether the marker determines that traffic is heavy or light. Under heavy traffic conditions all hold magnets are operated at the same time with a minimum of checks and tests to reduce marker holding time. Under light traffic condition, operation of the line hold magnet is delayed to permit a test of the talking path for crosses. After the line hold magnet has operated, a continuity test of the talking path crosspoints is made.

Headings of the following paragraphs are designated HTR, LTR or HTR/LTR as an indication that the paragraph applies only to heavy traffic, only to light traffic, or to either heavy or light traffic operation.

D6-3.1 DETERMINATION OF LIGHT OR HEAVY TRAFFIC BY CM-HTR/LTR

Hold magnet operation, as well as other marker functions, differ according to whether traffic is light or heavy. The CM determines whether the traffic is light or heavy by measuring the time between seizures of the CM using the HTT timer (SFD-D215).

At the beginning of a call, the MCB- relays of the CM are operated over the MB lead from the IRMC (SFD-D206). The MCB1 relay operated extends ground on the TM lead to operate the OAT relay. If the HTR relay is already operated from the last call it remains locked to ground through normal contacts of the HTT relay (SFD-D215). At the end of the call, the OAT relay releases. If the HTR relay is not already operated, it operates and locks releasing the OAT1 relay. With the OAT and OAT1 relays normal and the HTR relay operated, the shunt around the HTT capacitor (SFD-D215) is opened allowing the HTT capacitor to charge until the HTT tube fires and operates the HTT relay or until the CM is seized again and the OAT relay operates to stop the timing. If the time between calls is greater than 0.96 to 1.6 seconds, the HTT relay operates releasing the HTR relay so that the next call is handled on a light traffic basis. If the interval is shorter than 0.96 to 1.6 seconds, the HTR relay remains operated and the call is handled on a heavy traffic basis.

D6-3.2 HOLD MAGNET TIMING - HTR/LTR (SFD-D622)

As described in preceding paragraphs, select magnets are operated on line link and trunk link frames upon operation of a CH- relay. Operation of a CH- relay also operates the CHA relay which starts a hold magnet timing interval. This time interval is necessary to allow select magnets to operate, for select fingers to seat, and for any previously operated hold magnets connected to this channel to release before operating hold magnets for this call.

Prior to operation of the CHA relay, current flows through the primary winding of the HMT relay in a direction to operate it, while current through the secondary flows in a direction to release it. The combination of external resistance, winding resistance, and difference in number of turns is such that the current in the secondary prevents the HMT relay from operating. When the CHA relay operates, current in the secondary decreases as the HMT capacitor charges. When the effect of the current in the secondary becomes less than that of the current in the primary, the HMT relay operates. This operate time can be set at 43-50 ms by cross-connecting terminal HMT1 to HMT3 or to 63-75 ms by cross-connecting terminal HMT1 to HMT2. The longer time interval is required in offices which have some switches which are not equipped with damping cones, since the select fingers on these switches take longer to settle down. Operation of the HMT relay operates the HMT1 relay.

D6-3.3 CHECK OF CHANNEL - HTR/LTR

Early in the call, the SLRK relay operates (SFD-D623) from ground on the LLC3 relay through normal contacts of the following relays to ensure that they are initially normal: SLA, TGCK, JGCK, GLH1, GT2, HMT1 and CHA1. The SLRK locks when the TK relay operates. If the SLRK relay fails to operate, operation of a CH- relay (SFD-D617) is prevented.

In the process of channel test (SCD-D6-1.15, SFD-D616) busy channels are detected by looking for ground on sleeve leads. If ground is not detected on any of the three parts of a channel, it is presumed to be idle and one of the "idle" channels is selected by operation of a CH- relay (SFD-D617).

A further check of the channel is made after a CH- relay has operated. The JGCK and TGCK relays (SFD-D625) are connected to junctor and trunk hold magnet leads, respectively. These are high resistance sensitive relays which operate to battery on hold magnet windings without operating the hold magnets. This provides a positive check that the hold magnets associated with the channel are idle (ungrounded). A further check of the sleeve of the line link selected is made by the LLT relay. If the line link is idle (ungrounded) the LLT relay will not operate. (SFD-D616).

D6-3.4 CROSS CHECK OF TRUNK SLEEVE - HTR/LTR

Prior to operation of the HMS1 relay, the XSL relay is connected to the AST or BST lead (SFD-D625) to detect any cross to ground. If the XSL relay operates, it locks and operates the MXT relay which causes a trouble record showing an XSL punch.

D6-3.5 HOLD MAGNET START - HTR/LTR, (SFD-D623)

With the HMT1, JGCK, TGCK, and SLRK relays operated, and other check relays released, the HMS1 relay operates to start hold magnet operation. The operation of the HMS1 relay closes circuits for operating the LL and TL hold magnets and the line hold magnet of the channel.

D6-3.6 HOLD MAGNET OPERATION - HTR/LTR (SFD-D625)

The operation of the HMS1 closes the operate circuit over the LH-, J-, and LH-(TL) leads to the LL and TL hold magnets of the selected channel. Relay HMS1 operated extends the +130 volts on the LH, JH-, and TH-capacitors to the winding of the hold magnets. The capacitors discharge through the hold magnets, causing them to operate. When the voltage across the capacitor drops to about -.5 volts the LH, JH-, and TH-diodes become forward biased and pass a steady current to hold the hold magnets operated.

The TL trunk and junctor hold magnets and the LL junctor hold magnet are always operated on a dual voltage basis.

D6-3.7 DUAL VOLTAGE OPERATION - HTR/LTR (SFD-D625)

With the standard dual voltage option, all hold magnets except the line hold magnet are operated by a high voltage surge on all calls. The line hold magnet is operated by the high voltage surge except on calls to message rate lines in offices having message registers. This is to avoid the possibility of falsely operating the message register. Lines equipped with message registers are indicated to the marker over the class-of-service leads from the LL. The class-of-service indication is received over the CS00-29 leads, which in turn are cross-connected to operate relay CNA (coinline auxiliary), AOA (all other auxiliary), MRA (message registers auxiliary), or CGS (centrex station). The operation of the CNA, AOA, or CGS relays operates the DVO relay, which in turn operates the DVA relay indicating that the marker should use dual voltage to operate the line hold magnet. The operation of the MRA indicates 48 volt operation for the line hold magnet.

With DVA or MRA operated and the HMT operated, ground is closed to operate the HMT1 relay.

D6-3.8 OPERATION OF LINE HOLD MAGNETS - HTR (SFD-D625)

Assume a heavy traffic call with a nonmessage rate line. Upon operation of the HMS1 relay, with the HTR, DVO and DVA relays operated, ground is

furnished through the primary winding of the LXP relay in series with the LH capacitor. The LH capacitor (which has previously been charged to +130 volts and acts momentarily like a 130 volt battery) is applied to the winding of the line hold magnet which is connected to -48 volt battery. The effect is as though a battery of 178 volts were connected to the relay winding. The voltage of the LH capacitor rapidly decreases to 0 and then to a fraction of a volt negative at which point the LH diode begins to conduct, so that the hold magnet is held operated to ground potential. Application of high voltage in this manner causes the hold magnet to operate in about 1/3 the time it would take if 48 rather than 178 volt operation were used.

If the DVO and DVA relays are normal, 48-volt operation is used. That is, the ground through the winding of the LXP relay is applied directly to the hold magnet without the LH capacitor in series.

With or without surge voltage operation, the LXP relay operates in series with the line hold magnet. The LXP relay operates the LXPA relay which locks (SFD-D623).

D6-3.9 OPERATION OF JUNCTOR AND TRUNK HOLD MAGNETS - HTR/LTR (SFD-D625, D623)

The HMS1 relay closes ground through the JXP relay primary winding in series with the JH capacitor charged to +130 volts over the J- lead to the winding of the line link junctor hold magnet.

The HMS1 relay also closes ground through the TXP, TXP1 resistance lamps in series with the TH1, 2 and 3 capacitors charged to +130 volts over the LH- lead to the trunk and trunk junctor hold magnets. As described for high voltage surge operation of line hold magnets, the magnets operate in about 1/3 of the time required for 48-volt operation. When the capacitor discharges, the magnets continue to be held operated through the diodes to ground through the JXP relay or the TXP, TXP1 resistance lamp. The JXP relay operates in series with the line junctor hold magnet and operates the JXPA relay which locks.

D6-3.10 CROSSPOINT CHECK - HTR/LTR (SFD-D625, D623, D616)

D6-3.10.1 Heavy Traffic

When the hold magnets have operated, the low resistance ground from the TXP, TXP1 resistance lamps operates the SL relay and releases the LXP and JXP relays which operate the LXPl and JXP1 relays, respectively. The SL relay operates the SLA relay (SFD-D625). The LLT (SFD-D616) relay, which has previously operated when operation of the line junctor hold magnet grounded the line link sleeve, operates the LLTA relay. Operation of the SLA, LLTA, LXPl and JXP1 relays closes ground through the previously operated HTR relay to operate the GT1 relay, which locks.

D6-3.10.2 Light Traffic

Crosspoint check on light traffic is the same as preceding, except:

- (a) Line hold magnet operation does not occur at the same time as operation of the other hold magnets when the HTR relay is not operated.
- (b) Operation of the SLA, LLTA and JXP1 relays closes ground through the normal HTR, LXPA and LXPI relay contacts to operate the LTR (light traffic) relay instead of the GT1 relay.

D6-3.11 FALSE CROSS AND GROUND TEST - LTR (SFD-D627)

On light traffic calls, a test for crosses on the network tip and ring conductors is made. For this reason, the operation of the line hold magnet operation is delayed during the test so that crosses or grounds external to the network are not detected.

Ground through the secondary, and battery through the primary windings of the FCG relay are connected to the ATT or BTT and ART or BRT leads, respectively.

The FCG relay will operate if there is a false ground on the ring conductor at any point from the nonoperated LL line hold magnet crosspoints to the primary winding of the FCG relay. If there is a false battery on the tip conductor at any point, the FCG is operated by current through the secondary winding. Or, if there is a false cross between the tip and ring conductors at any point, the FCG relay is operated by current through the primary and secondary windings. The operation of the FCG relay would stop the progress of the call and produce a trouble record showing the FCG punch.

When the LTR relay operates, indicating that all crosspoints other than those for the line hold magnet have closed, a locking ground is provided for the FCG relay in case it has operated. If the FCG relay has not operated, the GLH relay operates (SFD-D622).

The GLH relay disconnects the FCG relay from the ATT or BTT and ART or BRT leads and grounds both leads to discharge any voltage remaining on them from the FCG test.

D6-3.12 DELAYED OPERATION OF LINE HOLD MAGNET - LTR (SFD-D622)

The GLH relay operates the GLH1 relay. With the GLH1 relays operated, the line hold magnet is connected either in series with the LXP primary winding to ground (if the DVO and DVA relays are normal) or in series with the charged LH capacitor to ground through the LXP primary winding,

if the DVO and DVA relays are operated. The operated LXP relay operates the LXPA relay. When the line crosspoints close, the LXP relay is forced to release by ground from the TXP and TXPl resistance lamps. This operates the LXPl relay.

D6-3.13 CONTINUITY TEST, GENERAL - LTR (SFD-D627)

A continuity test of the talking path through the network is made on light traffic calls. In order to check continuity of the path through the network, a path from tip to ring conductors or from either tip or ring to ground external to the network is required. Twenty-cycle (AC-DC-AUD) ringing supply is stepped up to a higher voltage by the CON2 transformer. With the GLH1 relay normal, the output of the CON2 transformer is open-circuited. There is no current flowing and, therefore, no voltage buildup across the CON2 capacitor. When GLH1 relay operates (assume RCTA relay normal) the CON2 transformer is connected through the network to the ring side of the line. Ground is connected to the tip side. On nearly all calls, the off-hook status will be connected across the tip and ring so that there will be a relatively low dc resistance in the loop. Current will flow, causing an alternating voltage to appear across the CON2 capacitor. Terminal 1 of the CON tube is connected through the CON1 resistor to the CON2 capacitor. If the voltage at terminal 1 reaches the firing voltage of the CON tube, even momentarily, the CON tube fires and continues to conduct between terminals 2 and 4 to operate the CON relay even though the voltage at terminal 1 is no longer above the firing voltage.

Occasionally the station will go on-hook just before the continuity test is applied. If this is an individual line, the path through the ringer and the series capacitor allows sufficient 20-cycle (AC-DC-AUD) frequency current to flow to raise the voltage across the CON2 capacitor to the firing voltage. The same holds true for a ring party line. In this case, current flows through the network ring lead only through the ringer and capacitor to ground and back through the earth to the central office ground. If there is only a tip party connected to the line, insufficient current may flow and the CON tube may not fire at this time (still assuming that the RCTA relay is normal at the beginning of the continuity test.) As described in more detail later, the RCTA relay operates after a short interval to reverse the continuity test. Now, current flows through the tip lead through the tip party bell and capacitor, back through the earth to the central office ground. If the RCTA relay had been initially operated and only a ring party station had been connected, the RCTA relay would have released to apply the continuity test to the ring side of the line.

On long lines, the cable capacity is sufficient to satisfy the continuity test even if there is no other path through ringers or transmitter.

D6-3.13.1 Continuity Test Reversal Control - LTR (SFD-D627)

The RCTB relay operates from ground through the HTR relay contacts normal, and prevents the RCTA relay operation for ring party stations. On continuity test of a multiparty line, the ring side of the line is tested first. If the continuity test is satisfactory, the operation of the CON1 relay locks the RCTB relay operated. If the continuity test is not satisfactory, the RCTB relay releases when the LXP1 operates, and causes the RCTA relay to operate. The operated RCTA removes the continuity test from the ring and applies it to the tip conductor.

D6-3.13.2 Continuity Test Description - LTR (SFD-D627)

Operation of the GLH1 relay, in addition to starting operation of the line hold magnet, also starts the continuity test. Stepped up 20-cycle ringing supply voltage through the CON2 transformer in series with the CON2 capacitor to ground is applied to either the tip or to the ring of the path through the network depending on whether the RCTA relay is operated or normal. Ground is applied to the other side of the path through the network. The GLH1 relay also applied +130 volts to a voltage divider supplying the winding of the CON relay.

If there is continuity through the crosspoints and continuity external to the network, the voltage across the CON2 capacitor builds up sufficiently to fire the CON tube. The CON relay operates, in turn operating the CONA relay. The CONA relay operates the CON1 relay which locks. The CON1 relay closes a locking path to prevent release of the RCTB relay (if it has not already released), operates the GT1 relay which locks, and grounds the control terminal 1 of the CON tube. The GT1 relay removes positive battery from the CON relay allowing it to release. This, combined with the grounding of control terminal 1, extinguishes the CON tube.

The CON1 and CON3 capacitors are small and serve to prevent false firing of the CON tube from electrical noise pulses.

D6-3.13.3 Continuity Failure Trouble Record - LTR

If the CON tube fails to fire, the CON and CON1 relays do not operate, and the CM cannot proceed with the call. The work timer which is recycled upon operation of the GLH relay (SFD-D215) times out after 450 to 605 milliseconds. This causes a trouble record showing WT, GLH and all progress punches through the DCT (but does not include the CON punch).

D6-3.13.4 Cancel Continuity - LTR (SFD-D622, D623, D627)

On second trial calls, the operation of the GLH1 relay operates the CON1 relay from ground on the operated TR2C (SFD-D622), thus, automatically canceling the continuity test. On heavy traffic calls, operation of the LXP1 relay with the HTR relay operated (SFD-D623) operates the GT1 relay, thus, canceling continuity test by bypassing operation of both the CON and CON1 relays.

Continuity test can be cancelled on all calls for all markers by operating the CCT key at the master test frame jack lamp and key panel (SFD-D627).

D6-3.14 DOUBLE CONNECTION TEST - HTR/LTR (SFD-D625)

On both light and heavy traffic calls a double connection test is made to ensure that the sleeve of the connection being set up is not crossed with the sleeve of another connection already set up or in the process of being set up. Although operation of the line hold magnet is slightly delayed on light traffic calls, the double connection test is made in the same manner on both light and heavy traffic calls.

When the LXP1, JXP1 and SLA relays have all operated, as previously described, the LXP and JXP relays and the TXP and TXP1 resistance lamps are disconnected from respective leads to line and trunk link frames. At the same time the DCT relay is connected to the LH- lead to the line link frame. The DCT relay winding now provides the only ground from the CM to keep the hold magnets operated. Bias current through the secondary winding of the DCT relay is such that the DCT relay will operate if there is no other ground feeding the connection such as would occur if the sleeve path were crossed to an established network connection.

D6-3.14.1 Heavy Traffic

On a heavy traffic call the GT1 relay operates upon completion of the crosspoint check (SCD-D6-3.10.1). With the GT1 relay operated, operation of the DCT relay operates the DCT1 relay which locks.

D6-3.14.2 Light Traffic

On a light traffic call, the GT1 relay does not operate until the CON1 relay has operated as a result of a successful or cancelled continuity test. With the GT1 relay operated, operation of the DCT relay operates the DCT1 relay which locks.

D6-3.15 HOLD MAGNET SIMULATION AND CONTROL BY MTC (SFD-D624, D625)

On an incoming class of marker test, it is desirable to be able to test the marker using any line location information. To avoid the possibility of having a customers line become locked into the test call if the line should happen to go off-hook during the progress of setting up the test connection, line hold magnet operation is simulated.

D6-3.15.1 NTC Key Normal

The MT11 relay of the CM is operated on test calls. This opens the path over the LH- lead (SFD-D625) to the line link frame which would normally be used to operate the line hold magnet on a service call. Instead, on a test call the path is extended over the LHMT lead to the MTC and

through the MKT2 relay to the LHM relay (NTC key and NTC1 relay normal) (SFD-D624). The LHM relay and the series LHM resistance are chosen to present an impedance to the marker equivalent to that of a line hold magnet.

When the HMS1 relay of the marker operates, the marker applies either the high voltage surge for dual voltage or ground through the winding of the LXP relay to operate the LHM relay of the MTC. The LHM relay operates the LHMA relay which extends the LHMT lead to the LLJ lead. The LLJ lead ties into the J lead of the CM to the trunk link frame at a point ahead of the CH- relay to simulate the path which would have been closed on a service call over the LH- relay lead to the LL, through the junctor and back over the J- lead to the CM. This permits the marker to go through all the motions of crosspoint and double connection checks. It will actually close junctor crosspoints on the LL, but checks are made through the simulated path just described. The CM operates and checks crosspoints on the TL in the normal manner.

D6-3.15.2 NTC Key Operated (SFD-D624, D625, and D631)

The NTC key of the MTC is operated on an incoming class of test where it is desired to establish a connection and check the tip, ring and sleeve path through the line link frame using all crosspoints which would be used on a service call except the line hold magnet crosspoints. Use is made of the no test connector access to LL frames.

Operation of the NTC key on incoming class of test operates the NTC and NTC1 relays. The operation of the NTC and NTC1 relays prepares the test circuit for operation with the no-test connector.

When the MTC gains access to the no test connector, the F1 relay of the MTC is operated over the SPC lead (SFD-D624). Operation of the F1 relay operates the NTC select magnets (associated with no test connector level assigned to the MTC) on all no test connector switches (see SFD-D631 as well as D625). The F1 relay also connects the NTB relay of the MTC to the no test connector via the NTH lead. The NTH lead is steered through the CM and the HGA- relay of the LL to the winding of the NTC hold magnet of the no test connector associated with the link to be simulated. If the NTC hold magnet is in use, ground on its winding will be fed back to operate the NTB relay of the MTC which locks on its secondary winding and lights an NTB lamp to indicate NO TEST BUSY. If this occurs, simulated hold magnet operation by the no test connector is blocked. The CM work timer times out and a trouble card showing LXPA but not LXP1 would be produced followed by release.

If the NTC hold magnet is not in use, the NTB relay does not operate. Later in the call, when the CM grounds LHMT lead (which on a regular call would operate the line hold magnet), the NTH relay of the MTC is operated. The NTH relay extends ground from the NTB relay normal to the NTH lead to operate the NTC hold magnet of the no test connector, extends the LHMT lead to the S lead, and closes the tip and ring leads to the test circuit trunk appearance on the no-test connector (SFD-D627).

On an incoming test the LK1 relay is operated through the operated MC7 relay (SFD-D704). The operated LK1 relay opens the H lead to the no-test connector to release the no-test connector hold magnet which opens the S lead and releases the NTH relay (SFD-D624). After the LK1 relay has operated, it releases the no-test hold magnets and the NTH relay.

D6-3.15.3 Dual Voltage Test (SFD-D624, D625)

When dual voltage operation is provided, the LHMT, LLJ and TLH relays of the MTC are connected to the LHMT, LLJ and TLH leads, respectively. If the CM applies the high positive voltage surge to each of these leads, the corresponding relays should operate to light the LHMT, LLJ and TLH lamps, respectively. Current through the lamps also locks the relays. Tests should be made using message register class of service, if provided, to ensure that the high voltage surge is not applied and, therefore, that the LHMT lamp does not light for these classes. The LHMT lamp should light for all other classes. The LLJ and TLH lamps should light for all classes.

D6-3.16 TEST OF FALSE CROSS AND GROUND DETECTION FEATURE (SFD-D627)

D6-3.16.1 FCG Key Normal

With the FCG key normal, the FCG relay of the CM is connected to the network T and R leads prior to operation of the GLH and GLH1 relays. As on service calls, crosses or grounds on the T and R leads will be detected on light traffic calls.

D6-3.16.2 FCG Key Operated

With the FCG key operated, the FA resistor is bridged across the TTT and TRT leads to the marker. This applies a current which should operate the FCG relay causing a trouble card to be produced showing a FCG punch. If the HTR key is operated, the CM should not detect the FCG condition.

D6-3.17 TEST OF CONTINUITY TEST FEATURES (SFD-D627)

D6-3.17.1 CON, RV, AND TCT Keys Normal, TC Key Operated or Normal

With the CON, RV, TCT, and TC keys normal, an operate condition originating at the voltage divider resistors CL, CM and CK, through the CF resistor is applied to the TRT lead. On alternate test calls the RCTA relay of the CM is operated so that the initial continuity test is made on the RING lead (the TRT lead on a test call). The CON tube should fire and the call should be completed. On calls with the RCTA relay of the CM normal, the initial continuity test is made on the TIP lead (the TTT lead on a test call). Since the TTT lead is open, the CON tube does

not fire initially, but (as described for a service call) it should fire after release of the RCTA relay applies the continuity test to the TRT lead. Two consecutive calls should be made to ensure one test with RCTA initially normal and one test with RCTA initially operated. With the TC key normal, a negative bias is applied to the operate path of the CON tube. A test should also be made with the TC key operated to apply a positive bias to the CON tube operate path.

D6-3.17.2 RV Key Operated, CON and TCT Keys Normal, TC Key Operated or Normal

Operation of the RV key with the CON, TCT, and TC keys normal applies the aforementioned continuity operate test condition to the TTT lead instead of the TRT lead. Two consecutive tests should be made to ensure one test with RCTA initially operated and one test with RCTA initially normal. As described previously, The TC key may be operated or normal to apply positive or negative bias to the CON tube operate path.

D6-3.17.3 CON Key Operated, RV, TCT, and TC Keys Normal

With the CON key operated, a loop continuity operate condition is applied across the TRT and TTT leads. The CON tube should fire for OK continuity on its initial attempt whether the RCTA relay is operated or normal.

D6-4 RINGING SELECTION SWITCH CONTROL

The marker receives the equipment location and the ringing information from the NG at the same time. The marker controls the selection of the ringing selection switch for ringing the called station or for returning line busy or overflow signals to the trunk.

One of two ringing selection switch select magnets (levels 0 or 1) is operated to select the tip and ring conductor to which the ringing should be applied. One of seven other select magnets (levels 2 to 8) is operated to select the proper ringing supply. The remaining select magnet (level 9) is used to control the line busy or overflow signals returned to the trunk. For this condition the 0 and 1 magnets distinguish between busy and overflow. By operating a hold magnet associated with the selected trunk, the proper ringing supply is connected through the crossbar switch crosspoints.

D6-4.1 SETTING THE RINGING SELECTION SWITCH (SFD-D628, D629)

The marker identification of the ringing combination translation is made by the one operated RCT1-15 relay, which operates two of the associated ringing selection RS0-9 relays. The RS2-9 relays operate select magnets

2-9 first. The CM RSK (ringing switch select magnet check) relay checks for operation of select magnets 2-9. The operated RSK relay provides battery for operation of select magnets 0 or 1. The CM SRK (start ringing check) relay operates when the select magnets are operated.

D6-4.2 RINGING SWITCH HOLD MAGNET OPERATION (SFD-D629)

The CM checks that an idle channel is available before operating the LI (link idle) relay. The operated LI relay extends ground on the RC lead to operate the RC (ringing control) relay in the trunk. After operation of relay RC, ground is extended from the marker on lead TP to operate the RSW (ring switch) hold magnet. Through the operated RSW crosspoints ground is returned on lead RC through RCK2 resistor to -48 volts to operate the RCK1 (ringing switch check) relay, which operates the RCK2 relay. Through the operated RCK2 and LCH or TCH relays the RCK3 relay is operated, which allows the call to complete.

D6-4.3 RINGING SWITCH SELECT MAGNET SIMULATION BY MTC (SFD-D628)

The KRS relay is operated by the F relay and closes the RS0-9 leads from the marker to the windings of the RS0-9 relays which simulate ringing switch select magnets.

The marker normally grounds the RS0 or RS1 lead and one of the RS2-9 leads, operating the corresponding relays which lock on secondary windings to ground on the RSH relay. Any of the RS0-9 relays operated, grounds the RSK lead to the marker.

Lamps are lighted, on the test panel, by the operated RS0-9 relay to indicate the ringing condition which would have been set up by a ringing switch.

D6-4.4 RINGING SWITCH HOLD MAGNET SIMULATION BY MTC (SFD-D629)

The marker having operated the RC relay, grounds the TP' lead to the RSH (ring switch hold magnet) relay which operates, simulating the operation of a ringing switch hold magnet.

When the F relay releases, the holding path of the RSH relay is through the operated RSH and N1 relays to ground through normal contacts of the KR relay.

D6-4.5 RINGING SELECTION SWITCH CONTROL FOR BUSY TONE (SFD-D628)

On a TER call, a line busy condition operates a BY (busy) relay. This releases the LL by releasing the LLCI relay in the marker. The BY relay also releases the RS- relay, which releases the previously selected ringing switch select magnets and in turn, releases the RSK relay. The

RSK and SRK, in releasing, operate the OFH (overflow hold magnet) relay and cause the operation of the ringing switch select magnets 1 and 9 (SFD-D628), which is the combination for signaling the trunk to return busy tone.

D6-4.6 RINGING SELECTION SWITCH CONTROL FOR OVERFLOW TONE (SFD-D630)

On a TER call, all channels busy condition operates an OV (overflow) relay. This releases the LL by releasing the LLC1 relay in the marker. The OV relay also releases the RS- relay which releases the previously selected ringing switch select magnets and, in turn, releases the RSK relay. The RSK and SRK, in releasing, operate the OFH relay and cause the operation of the ringing switch select magnet 0 and 9 (SFD-D628) which is the combination for signaling the trunk to return overflow tone.

D6-4.7 RINGING SELECTION SWITCH CONTROL FOR REORDER (SFD-D630)

The incoming registers are equipped with overall timers (SCD-D1-6). This timer serves to prevent any trunk from holding the register out of service for a long period of time. It is recycled on an interdigital basis so as to keep its time reasonably short and yet allow sufficient time for normal functions.

In the event the seizure interval or any of the interdigital intervals exceed the allowable time, the TM relay will operate to operate the R0 (reorder) relay. The operated R0 will ground the R0 lead to the marker to operate the R0 relay in the marker as an indication that a time out has taken place. The R0 operates the ROA which operates the OV. With the operation of the OV relay, the operation will continue as described in paragraph SCD-D6-4.6.

SECTION D, PART 7
COMPLETING MARKER RELEASE

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D7 COMPLETING MARKER RELEASE, RINGING CALLED SUBSCRIBER, AND DISCONNECT

The completing marker may encounter numerous conditions that require disconnect, and when these conditions occur the CM has various methods of disconnection.

When the F relay in the incoming trunk is released, the ringing selection switch supplies ringing to the called subscriber. After the called subscriber answers and conversation is complete, there may be two types of disconnect. The calling subscriber may disconnect first or the called subscriber may disconnect first.

D7-1 MARKER NORMAL RELEASE - OPERATION OF THE DIS1,2 RELAYS (SFD-D702, D704, D705)

When the marker has completed all functions successfully without encountering any trouble, the LK1 (linkage check) relay will operate causing the DIS1,2 (disconnect) relays in the CM to operate.

The DIS1,2 relays, operating, release the CKG1,2 relays in the CM and grounds the MRL lead into the IR (incoming register) to operate the MRL relay (SFD-D207). The MRL relay, operating, releases the MS- relay in the IRMC, and by opening the start lead into the connector prevents a second trial (SFD-D204).

D7-1.1 TROUBLE RECORD - OPERATION OF THE TRR RELAY (SFD-D702, D705, D708)

There are conditions whereby the CM detects trouble and, before releasing, takes a trouble record by operating the TRR (trouble record regular) release relay. These conditions are as follows.

When the start lead is shifted to an alternate marker in the IRMC due to a delay in the selection of a marker, the TRS (transfer start) relay in the PC circuit operates. After an alternate marker is selected, the TRS relay in the CM operates. The TRS relay operates the TRR relay in the CM and a trouble record is then taken. The TRS trouble record is used to identify the connector used on the call.

If the F terminal of a number in the NG is connected to the PBN or PMO lead, the CM will cause the line busy or overflow signal to be returned on calls to these numbers. The PBN feature is also used on test calls to test the ability of trunk circuits to return a line busy signal where a busy line is encountered (SFD-D414).

When the trouble record is completed, the DIS1,2 relays in the CM operate from the operated RDL, TRB1, TRSA and TRR relays. The marker then releases on a normal basis.

D7-2 MARKER TROUBLE RELEASE - OPERATION OF THE TRL RELAY
(SFD-D705)

If the CM encounters trouble while trying to complete the call, the TRL (trouble release) relay in the marker will operate. The TRL relay operating releases the CKG1,2 relays in the CM and grounds the TRL lead into the PC (preference control circuit) operating the TRL relay (SFD-D207). The TRL and TR relays operating release the MS- (marker start) relay in the IRMC. The Z relay in the PC changing condition shifts the ST (start lead) to the alternate marker and a second attempt is made to complete the call (SFD-D204). A trouble release permits a second trial providing the MRL or TRL relays in the IR (incoming register) are normal.

D7-2.1 TROUBLE RECORD - OPERATION OF THE TR1 RELAY (SFD-D705)

There are conditions whereby the CM detects trouble and, before releasing, takes a trouble record by operating the trouble record trouble release TR1 relay. These conditions are as follows.

A time out or cross failure will cause the CM to take a trouble record. If the marker usage is a first trial (TR2C relay normal), the TR1 relay in the CM operates and a trouble record is taken. A second trial is possible on this type of call because the IR is still attached to the circuit. If the marker usage is a second trial, TR2C relay operated, the TR1 relay in the CM operates and a trouble record is taken. Since the marker usage is a second trial, the TRL relay in the IR will operate opening the start lead preventing another attempt to complete the call.

When the trouble record is completed, the TRL relay in the CM operates from the operated TR1, TRB1, RDL, and TRSA relays. The marker then releases on a trouble basis.

D7-3 MARKER OVERALL TIME-OUT RELEASE - OPERATION OF THE MRL, MRL1
RELAYS (SFD-D207, D705)

If the marker fails to complete the call within the allotted interval of 9.6 to 15.4 seconds, the OAT timer functions and causes the MRL (marker release) relay in the CM to operate. The MRL relay operates the MRL1 relay (SFD-D705) which operates the TRL and MRL relays in the IR (SFD-D207). The MRL relay operating releases the MS- and connector relays in the IRMC and by opening the start lead into the connector prevents a second trial (SFD-D204). The MRL relay in the IR operated opens the locking path of the TRL allowing the TRL relay to release.

On this type of release, a trouble record is not taken but the TA (timing alarm) lamp will be lighted on the right COM EQPT marker frame.

D7-4 CONTROL OF MARKER RELEASE BY THE MASTER TEST CONTROL CIRCUIT (SFD-D704 AND D705)

On test calls certain MT- (marker test) relays operate in the CM. These test relays operating allow the MTC circuit to interact with the marker.

With the MT17 relay operated in the CM, the DCT1 relay operating path is extended into the MTC circuit over the TDCT lead. The DCT1 relay operating ground is extended over the DCT lead into the MTC circuit to operate the DCT relay in the MTC. With the REC key normal, the operation of the DCT relay in the MTC circuit operates the M01 relay (SFD-D705). The M01 relay in the MTC circuit operating connects ground to the TDCT lead into the CM operating the DCT1 relay (SFD-D704). The CM then continues its progress on a normal basis.

With the MT1 relay operated in the CM, the DIS1,2 relays operating path is extended into the MTC circuit over the DIS lead. After the LK1 (linkage check) relay in the CM operates, ground is extended over the LK2 lead into the MTC circuit. The LK2 relay in the MTC operates, lighting the LK2 lamp. Ground is now transmitted over the LK3 lead through the CM and back into the MTC on the DIS1 lead. The DIS1,2 relays in the MTC circuit operate, lighting the DIS1 lamp, and ground is extended over the DIS lead into the CM operating the DIS1,2 relays. The CM then gives a normal release. It may be noted that if the LK2 and DIS1 lamp at the MTC panel are both lighted, the marker has completed setting up the connection and released.

D7-4.1 REQUESTING TROUBLE RECORD USING MTC CIRCUIT - OPERATION OF THE REC RELAY (SFD-D705, D709)

When it is desired to obtain a record of the progress of the CM when making a test call, the REC key (record request) should be operated at the MTC panel. The REC key operates the REC relay in the MTC after the DCT relay has operated. Thus, the REC relay is operated prior to the completing marker DCT1 relay. The REC relay operated extends ground into the CM over the TRR lead to operate the TRR relay. The TRR relay operates the TRST (trouble recorder start) relay in the CM which operates the MPR- marker preference relay in the MTFC to request a trouble record. A trouble record is taken and the CM releases on a normal basis. These trouble records requested by the test equipment can be distinguished from service or legitimate trouble records by the absence of the TI (trouble indication) punch on the trouble record card.

D7-5 TROUBLE RECORDER REQUESTS (SFD-D709)

When the marker encounters a trouble condition, the TRR or TR1 relay will operate in the CM and cause the trouble recorder to be seized

by the trouble recorder start relay operating (SFD-D705). The TRST operates the TRSA relay in the marker. On first trial calls, the MN relay in the JLK circuit operates and a minor alarm is sounded. On second trial calls, the MJ relay in the JLK circuit operates and a major alarm is sounded. The marker preference MPR- relay in the MTFC circuit is then operated from battery on the TRST lead. The MPR- relay connects ground to the CI lead which operates the MKA, MKB, and MKB1 relays in the MTFC. The MKA relay operates the MTR (marker test repeat) relay which operates the CIC (cut-in connector) relay in the MTFC and a trouble record is taken.

After the trouble record is complete, ground over the TRC lead from the TRC (trouble recorder control) circuit operates the TRC and TRC1 (trouble record complete) relays in the MTFC. The RM (release marker) relay in the MTFC operates and ground is transmitted over the TRB lead into the CM to operate the TRB1,2 (trouble recorder busy) relays. The TRB1 relay operating removes battery from the TRST lead releasing the MPR- and MKA relays in the MTFC. The TRB2 relay operates the RDL (release delay) relay in the marker. The marker will then release on a normal or trouble basis.

D7-5.1 TROUBLE RECORDER BUSY (SFD-D709)

When a trouble record is requested by the marker with the operation of the TRR or TR1 relays and there is a previous trouble record in progress with the TRB1 relay operated, the DL (display lost) relay in the marker will operate. The DL relay operating will cause the DL- (display lost) lamp in the JLK circuit to light, indicating the loss of a trouble record. The marker will then release on a normal or trouble basis.

D7-6 RINGING THE CALLED SUBSCRIBER (SFD-D707)

When the CM releases the F relay in the incoming trunk, control of the ringing selection switch hold magnet is transferred to the incoming trunk. Ground is removed from the FA lead releasing the TL auxiliary relays. On "one ring" codes, the PU relay operates from ground on the PKU lead as soon as the crosspoints close. On other than "one ring" codes, the PU relay is operated by a ground pulse from the ringing machine on the PU lead just before the start of a complete ringing cycle. In either case, the PU relay locks to ground through the D relay under control of the RC relay and connects ringing current through the winding of RT relay and contacts of RC relay to the called line. Ringing current is returned to the calling subscriber through the T1 and R1 capacitors as an audible indication that ringing has begun.

The operated ringing switch hold magnet closes crosspoints of the two selected levels to extend ringing current and ground to the T and R leads of the trunk circuit (SFD-D706). The path of ringing current may be traced from the ringing supply through crosspoints of selected level 2-8, to the RT lead, through the RT relay in the incoming trunk circuit, to the RB lead, through crosspoints of level 0 or 1, to T or R lead, through called subscribers sub-set back to level 0 or 1 to ground.

D7-7 CALLED SUBSCRIBER ANSWERS

When the called subscriber removes the receiver to answer the call, the RT (ringing trip) relay operates from the increased current flow through the sub-set. The RT relay opens the locking path for the RC relay causing it to release. The released RC relay reconnects the called line to the S relay causing the S relay to operate. The released RC relay also causes a 10 ohm ground to be connected to the channel of the called line to hold the channel operated and releases the PU relay. The S relay is also in the path to keep the channel operated and, if supervision is required for billing purposes, operates the T relay.

D7-8 DISCONNECT (SFD-D707)

After conversation has ended, disconnect from the line varies, depending on whether the called subscriber or the calling subscriber disconnects first.

D7-8.1 CALLED SUBSCRIBER DISCONNECTS FIRST

When the called subscriber disconnects, the S relay releases. The released S relay removes the holding ground from the sleeve lead and releases the T relay (if it is operated). The T relay restores the original trunk polarity as a disconnect signal to the distant office. When the calling end disconnects, the A relay in the incoming trunk releases, opening the locking path of the D relay. The released D relay releases the CO relay, the ringing switch vertical and the connection to the calling line. This restores the trunk and network connection to normal.

D7-8.2 CALLING SUBSCRIBER (OR STATION) DISCONNECTS FIRST

When the calling subscriber disconnects first, the A relay releases, in turn releasing the D relay. The released D relay releases the CO relay, the ringing selection switch, and opens one holding path to the called subscribers channel. The channel to the called subscriber will be held operated through the S relay operated and the RC relay released.

The CO relay released with S relay operated establishes a path to the heater element of the thermo controlled RL relay. In 13-32 seconds, the RL relay operates and causes the RC relay to operate. The operated RC relay opens the path to the called subscribers channel. This releases the channel which opens the T and R to the trunk. The open T and R leads release the S, RC, and RL relays and restores the trunk to normal.

SECTION D, PART 8
SPECIAL MARKER OPERATIONS

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D8 SPECIAL MARKER OPERATIONS

There are certain test calls that require special handling. The first two CMs in a marker group are equipped as special markers to handle these calls. Some of these are No-Test, No-Hunt, and Special-Hunt calls.

No-Test calls originate from a local or central DSA switchboard or test desk. These calls establish a connection between an IT (incoming trunk) and a busy line.

No-Hunt calls originate from the message register rack or master test control circuit. These calls test line message register operation and line failures.

Special-Hunt calls originate from a local or central test desk and are used to make voltmeter and other miscellaneous tests.

D8-1 ESTABLISHING THE CONNECTION

After the IR is attached to the trunk and ready to receive pulses, the numerical digits of the called line are dialed or keyed. The IT special class informs the IR by way of the IRL that a special marker is needed. The PC (preference control) circuit then selects a special CM (completing marker) and the CM is informed by the IRMC of the special nature of the call. The IT also tells the CM the type of special call by operating the no-test, no-hunt, or special-hunt relay. On no-hunt and special-hunt calls after marker seizure and preference are completed, the call is similar to a regular TER call except that the CON and GT tests are cancelled. On no-test calls after marker seizure and preference are completed and if the called line is busy, it is necessary to use the NTC circuit to connect the no-test IT to the called line. In offices that are equipped with message register operation, it is necessary to guard against false operation of the called line message register by the no-test circuitry.

The remainder of the NT call is similar to a regular TER call except that the CON and GT tests are cancelled.

D8-1.1 MARKER SEIZURE (SFD-D804)

After the IR (incoming register) is attached to the IT by the TP- relay in the IRL (incoming register link) the CLS relay in the IR operates. The class of the IT is determined by the TPC-- to CLO-10 cross connect in the IRL frame. The CLS relay operating causes the SPL relay in the PC circuit to operate which operates the CB- relay in the PC for all non-special markers in the same connector. Thus, the only markers in the connector available for seizure are the special markers. After the

marker connector relays have operated, the SPL relay in the PC operating extends ground over the SPL lead into the CM to operate the SPL, SPL1 relays which tells the CM that this is a special type call.

D8-1.2 SPECIAL MARKER PREFERENCE CONTROL (SFD-D804)

The SP0-2 relays in the MTFM circuit are provided to allow only one special call to proceed in case of simultaneous overlapping attempts by two or more circuits. These relays are associated with special markers 0(SP0), 1(SP1), and the MTC (SP2). They are wired so that the lowest SP- relay is preferred and operated from marker battery on the corresponding SP lead. The highest SP- relay is in the preferred position for returning ground on its SPC lead.

D8-1.3 INCOMING TRUNK AND RINGING SWITCH CONTROL (SFD-D805)

The IT indicates to the CM through the TLC (trunk link connector) the type of special call by grounding the NT (no-test), NN (special-hunt), or NH (no-hunt) lead, thus operating the associated relay. Ringing switch control is handled in the usual manner (SCD-D6-4).

D8-1.4 LINE IDLE AND LINE BUSY TESTS (SFD-D806)

The LI and LB tests are made and the call proceeds to take the appropriate action. On no-hunt and special-hunt calls if the called line is idle or busy the call proceeds similar to a regular TER call. On no-test calls if the called line is idle the call is similar to a regular TER call, but if the called line is busy the NTT relay in the CM operates calling in the no-test train.

D8-2 NO-HUNT AND SPECIAL-HUNT CALLS

The no-hunt and special-hunt calls must use special markers 0 and 1. No-hunt calls originate from the message register rack and MTC circuit, and test the operation of line message registers and test for line failures. Special-hunt calls originate from a local or central test desk and make voltmeter and other miscellaneous tests. Marker seizure and preference control are as described in D8-1.1 and D8-1.2. The IT indicates to the CM the type of special call by grounding a NH (no-hunt), or NN (special-hunt) lead (SFD-D805).

On a no-hunt call if the called line is busy, the IT sets the call to a busy condition.

On a special-hunt call, the operated SPH relay in the marker permits terminal hunting. A connection may be established to the called line in the terminal hunting group if the line is idle. If the called line is

busy, the marker selects the next preferred idle line within the terminal hunting group. If all lines within the hunting group are busy the marker starts the operations required to cause the IT to return a busy tone.

D8-3 NO-TEST CALLS

No-test calls must use special markers 0 and 1. No-test calls originate from a local or central DSA switchboard or test desk. They establish a connection between an IT and a busy line. The CM seizure and preference control are as described in D8-1.1 and D8-1.2. The IT indicates to the CM the type of special call by grounding the NT (no-test) lead (SFD-D805).

On no-test calls if the called line tests busy, the marker sets up a connection to the called line through the no-test connector and no test vertical on the line link frame. If the called line tests idle, the call proceeds similiar to a TER terminating call.

D8-3.1 NO-TEST, CALLED LINE BUSY

A called line busy condition indicates to the marker that a connection exists between the called line on the LL and a trunk on the TL. When the called line is busy, the marker is unable to establish a connection between the incoming trunk and the called line in the usual method. A NTC circuit provides means for connecting the no-test trunk to the busy called line. The NTC circuit consists of a crossbar switch having its horizontals connected to the no-test verticals on the LL frames (SFD-D808). By operating the proper NTC select and hold magnets and the proper LL line switch select and no-test vertical hold magnets, a connection can be made between the no-test incoming trunk and the LL on which the busy line is located.

D8-3.1.1 Connection of the No-Test Trunk to the Called Line Through the No-Test Connector

When the marker determines that the called line is busy, the LBTA (line busy test auxiliary) relay operates. The operated LBTA relay operates the NTT (no-test train) relay in the completing marker. The NTT initiates the operations required for connecting the no-test incoming trunk to the called line through the NTC circuit.

Upon seizure of the special marker, the SPL relay operates the NTC (no test timing) relay in the marker (SFD-D804). Although the NTC relay is operated on all special calls it is used only when the marker completes a no-test call via the NTC circuit. The slow release NTC relay is operated at this time to give it sufficient time to become fully saturated

to make its long release time effective. The NTC relay is used to time the seizure of a channel from the time a low positive potential of 10 volts is applied to the line links until the channel is selected. When failure to detect a channel occurs, or if the CH- relay fails to operate, the NTC relay releases to operate the BY relay and the call is set to busy tone.

After the F relay in the no-test IT operates, the NT relay in the completing marker operates (SFD-D805). This causes the NTH (no-test hold magnet) relay to operate which starts the operation of the slow operate NTR relay (SFD-D804). The NTH relay tests for an idle no-test junctor between the LL and NTC during the NTR relay slow operate time. The NTH relay extends the no-test connector H- hold magnet operate ground from the no-test IT over the NT lead through the LLC into the marker to operate the JB (juncor busy) relay if the no-test junctor is busy (SFD-D808). The JB relay operates the marker OV relay and overflow tone is returned by the trunk. If the no-test junctor is idle the NTR (no-test release) relay operates which in turn operates the NT5 relay.

The NT1 through NT5 relays operate to control the necessary circuit operations when the call is to be completed via the NTC. When the CHT relay operates after the channel test is made, and the NTT relay has operated, NT1, NT2, NT3, and NT4 relays in the CM operate.

D8-3.1.2 Identification of the Line Link (SFD-D808)

To make a connection between the LL no-test vertical and the called line, it is necessary to identify the line link connected to the called busy line. The sleeve conductors of the five lines within the selected line group are extended from the LL to the marker over the LHO-4 leads. The NT3 and NT4 marker relays operated cause a +10 volt potential to appear on the one busy sleeve of the called line. This low positive voltage is obtained by the voltage divider effect of the NT1 and NT2 resistors (SFD-D808). Tests leads designated LLO-9 are extended to the marker from the group of ten line links, within which the line link connected to the called line is located. In the marker, the LFO-9 (line link frame identifier) relays test for the presence of the +10 volts on the LLO-9 leads. One LFO-9 relay is operated. The operated LFO-9 relay operates the corresponding CHO-9 relay which operates the CHA and CHAI relays (SFD-D809).

D8-3.1.3 No-Test Connection to Busy Line

The CM operates the F relay in the no-test IT over the F lead via the IRMC and IRL frames (SFD-D805). The F relay then operates the F1 relay in the no-test trunk which extends ground over the JCO-7 leads into the NTC circuit to operate the associated S- select magnet. The CHO-9 relay also operates the CHA, which releases the NTH relay. Ground is then extended from the CM over the NT lead to the NTC circuit to operate the H- hold magnet (SFD-D808). The H- hold magnet make contacts in the NTC

extends its operating ground into the LL frame over the H lead to operate the NT hold magnet. With the H- and NT hold and L- select magnets operated, crosspoints are established between the LL and NTC, and the busy sleeve ground is extended into the no-test IT over the S lead to operate the H relay. Relay H provides a holding ground over the H lead for the H- and NT hold magnets.

After the channel has been selected and the NTH relay releases, the slow release NTR relay starts to release. The slow release of the NTR relay allows sufficient time for the operation of the hold magnets in the NTC and LL, along with the H relay in the no-test IT, before the LK1 relay in the CM is operated. The operation of the LK1 relay causes the marker DIS1, DIS2 relays to operate which releases the marker.

After the marker releases, no-test connection is maintained until either the operator or test deskperson disconnects, or the busy condition of the called line is removed.

D8-3.2 NO-TEST CALLS WITH MESSAGE REGISTER OPERATION

Message register operation is provided in an office to count the number of originating calls completed by a line. A message register is associated with a particular sleeve lead. On SOG and ITR calls the message register operates from potential provided by the trunk after the called customer answers. On no-test calls it is necessary to insure that the no-test connection does not interfere with the normal operation of the message registers.

On special calls the SPL relay operates in the CM. This causes the MN1 (monitor for no-test) relay in the marker to operate. Although the MN1 relay operates on every special call it is only used when the marker completes a NT call via the NTC and the office is equipped for message register operation.

D8-3.2.1 Message Register Potential Detected Early on Sleeve

On a no-test call if message register potential is detected on the sleeve after the NT1 operates, but before the NT3 relay operates, the message register potential will be extended from the LL to the CM over the LL0-9 lead and the associated PT0-9 tube conducts.

After the PT0-9 tube conducts, the MPT relay in the CM operates which releases the NT2 relay. The NT2 relay releasing prevents the marker from advancing to the point where a +10 volts is applied to the sleeve to operate the LF0-9 relays. When the message register potential is removed from the LL0-9 leads, the PT0-9 tube and MPT relay release re-operating the NT2 relay in the CM. The NT3 and NT4 relay then operates and a +10 volts from the voltage divider circuit is applied to the LH0-4 lead through the LL frame and over the LL0-9 lead to operate the LF0-9 relay in the marker. The operated LF0-9 relay operates the corresponding CH0-9 relay which operates the CHA and CHA1 relays (SFD-D809).

D8-3.2.2 Message Register Potential Detected on Sleeve while the LF0-9 Relays are Connected to the Line Links

On a no-test call if message register potential is detected on the sleeve after the NT3 relay operates and the +10 volts is extended to the LL0-9 leads, the M- (monitor for no-test) relay in the CM operates. The operated M- relay releases the NT1 relay and locks through its secondary winding in series with the MN relay in the marker, which also operates. The released NT1 relay releases relays NT2, NT3, and NT4 and removes the shunting effect of the LF0-9 relays from the 10 sleeve conductors. If this shunt is not removed the message register potential is reduced below that required to operate the message register. Relay MN operating releases relay MN1, which releases relay M- and MN. The MN1 relay reoperates and operates relay NT1, which connects the sleeve conductors through to the PT0-9 tube. If message register potential is still present on the sleeve, the associated PT0-9 tube conducts and the marker functions are as in D8-3.2.1. If no message register potential is present on the sleeve the marker proceeds to identify the LL by operating the LF0-9 relays.

D8-4 SIMULATING SPECIAL CALLS FROM THE MTC CIRCUIT

To test the special features of markers 0 and 1, the MTC circuit simulates the functions of special incoming trunks. The SPL key on the MTC panel is operated to inform the marker of the special nature of the call. The SPL key operates the SPL and SPL1 relays in the marker and the MTC then operates its F relay.

D8-4.1 SIMULATING NO-HUNT CALLS

On no-hunt calls with the F relay and NH key operated in the MTC, the NH relay in the marker operates. With the LB and LBL keys normal, simulating called line idle, the marker sets up a connection to the called line. With the LB key operated, simulating called line busy, the marker does not hunt and sets the relays simulating the RSW (ringing switch) in the MTC for a busy.

D8-4.2 SIMULATING SPECIAL-HUNT CALLS

On special-hunt calls with the F relay and NN key operated in the MTC, the SPH relay in the marker operates. The marker then hunts and establishes a connection to an idle line within the terminal hunting group. If all lines within the hunting group are busy, the marker sets the relays simulating the RSW in the MTC for a busy.

D8-4.3 SIMULATING NO-TEST CALLS

On no-test calls with the F relay and NT key operated in the MTC, the NT relay in the marker operates. With the LB and LBL keys normal,

simulating called line idle, the marker sets up a connection to the called line in the normal manner. With the LB key operated, simulating called line busy, the marker proceeds to set up a connection to the called line through the NTC. The operated MT16 (marker test) relay transfers the LLO-9 and LHO-4 (NTLH) leads from the LL to the MTC circuit. When the marker applies a +10 volts to the NTLH lead, it extends into the MTC circuit through the NA resistor and operated SO-9 key or switch to the LLO-9 lead into the marker to operate the LFO-9 relay. After the LFO-9 relay operates, the marker proceeds to set up the no-test connection. When testing from the MTC, the NTC hold magnet is operated, but, because the no-test IT is simulated, the select magnet in the NTC is not operated.

D8-4.3.1 Simulating No-Test Calls with Message Register Operation

The MTC circuit provides a means for testing the ability of the CM to detect message register potential on the sleeve when completing a no-test call. This is done by testing the operation of the marker PTO-9 tube, the PTL tube, and MPT relay.

The operated MT16 (marker test) relay transfers the LLO-9 and LHO-4 (NTLH) leads from the LL to the MTC. After the marker NT1 relay operates the PTO-9 tubes are connected to the LLO-9 leads. The MTC connects a positive potential from the voltage divider circuit to the LLO-9 leads by way of the make contacts of the NTT relay, break contacts of the LF1 relay, the PTL key normal, and SO-9 key or switch operated. The corresponding PTO-9 tube in the CM will then conduct. The PTO-9 tube conducting operates the MPT relay in the CM which operates the MPT relay in the MTC circuit. The MPT relay in the MTC operating removes the positive potential from the LLO-9 leads, thus releasing the PTO-9 tube and MPT relay in the CM.

When the marker NT3 and NT4 relays operate a +10 volts is transmitted over the NTLH lead into the MTC circuit which operates the LF relay. The operated LF relay in the MTC circuit operates the LF1 relay in the MTC. The LF1 relay operating releases the MPT relay in the MTC. With the LF1 relay and SO-9 key or switch operated, the MPT relay normal in the MTC connects a positive potential to the LLO-9 lead which operates the MO-9 relay in the CM. The operated MO-9 relay releases the NT1 and operates the MN relay in the CM. The marker NT1 relay releasing removes the marker +10 volt potential from the NTLH lead. With the positive potential removed from the NTLH lead, the LF relay in the MTC releases. The LF relay releasing operates the M relay in the MTC. The operation of the M relay reoperates the MPT relay in the MTC circuit. The operated marker MN relay releases the MN1 which releases the MO-9 and MN relay in the CM. The MN relay releasing reoperates the marker MN1 relay which operates relay NT1 and once more the PTO-9 tubes are connected to the LLO-9 leads. The MTC again connects a positive potential to the

LL0-9 leads from the voltage divider circuit and with the PTL key normal, the PT0-9 tube in the CM conducts. The PT0-9 tube conducting operates the MPT relay in the CM which operates the MPT relay in the MTC circuit. The MPT relay in the MTC operating removes the positive potential from the LL0-9 leads, thus releasing the PT0-9 tube and MPT relay in the CM. With the marker NT1, NT3, and NT4 relays operated, a +10 volts is applied to the NTLH leads into the MTC circuit through the M and MPT relays operated, and with the S0-9 keys or switch operated the corresponding LF0-9 relay in the CM operates. After the LF0-9 relay operates, the marker proceeds to set up the no-test connection.

With the PTL key operated in the MTC this test is as previously described except that an operate test of the PTL tube in the CM is substituted for the operate test of a PT0-9 tube by transferring the positive potential from the LL0-9 lead to the NTLH lead.

SECTION D, PART 9

MAINTENANCE

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D9 MAINTENANCE

This part of the D section covers some of the aspects of the use of the master test control frame to detect, locate, and clear trouble on incoming type calls.

D9-1 USE OF THE MASTER TEST CONTROL FRAME TO SIMULATE CALLS WHICH PRODUCE TROUBLE RECORDS

Analysis of trouble record cards using the trouble analysis chart and sequence charts of part D0 localizes the trouble to an area which may involve a path through one or two relay contacts within one circuit or may involve a path through many relay contacts in several circuits. Generally, it is not possible to troubleshoot the path on a static basis. The contacts which close to establish the path are often closed for only a fraction of a second during marker holding time. Frequently, the path which produced the failure is only used when a particular configuration of circuits or network paths are used. For this reason, it is desirable to be able to reproduce the same condition which caused the trouble in the first place. The master test control circuit provides the means for such controlled simulation of actual calls without affecting service.

D9-2 USE OF SIMULATION TABLE AND ILLUSTRATED TROUBLE RECORD CARD

The purpose of simulation tables on SFD-D902, D904, and D906 is to correlate trouble record card designations with the key(s) or switch(es) of the master test control frame which should be operated to provide the input or control to the CM when simulating a trouble record card. Included is the trouble card designation location for the different types of trouble cards for easier reference. The three types of trouble record cards illustrated are E-5488 (2/x double sided) E-4393 (1/x double sided) and E-3638 (1/x single sided) shown on SFD-D903, D905, and D907 respectively.

The drawing in SFD-D903, D905, and D907 depict a trouble record card which includes all the possible designations (colored) which might be perforated on a record produced by an incoming type call (TER). A color key arrangement has been used to indicate the different functions of designations regarding marker input or output information, progress of call, circuits or paths used, etc.

D9-2.1 FUNCTIONS OF INCOMING CLASS OF CALL (TER)

One of the tables on SFD-D902, D904, or D906 and the associated colored trouble record card which corresponds to the type of trouble record card being analyzed should be used. The tables are divided into two parts. The left-hand side of the chart shows functions used, designations perforated, and the designation location on a particular trouble record card. The right-hand side of the chart list the different key(s) or switch(es) used to simulate trouble record indications, depending on the type of master test control frame provided. The following is a brief description of the key and switch arrangement and their relationship to the trouble designation for each of the functions listed in above tables.

- (a) Select the TER class of marker test, by operating the INC, IR, ITNP, LT, or MLV key, if provided, or the TSTA or TSTB switch to the required position.
- (b) Select the class of call according to office A or B, physical or theoretical, and whether four or five digits are required.
- (c) Use the proper incoming trunk class according to the class of call. Only local charge (LCH) trunk classes are shown.
- (d) To simulate a special incoming trunk, the special key (SPL) must be operated to provide the marker with information normally supplied by an incoming register connected to a special incoming trunk. In addition, the NH key should be operated to simulate a no-hunt trunk. The NN key should be operated to simulate a trunk which is neither no-test nor no-hunt. The NT key should be operated to simulate a no-test trunk and one of the S (0-9) key or switch should be operated to direct the marker to the desired hunting features.
- (e) Select the particular CM which produced the record card.
- (f) Digits A (0-9) through E (0-9) should be operated to simulate the called number registered on the trouble record card. This chart is confined to four or five digit numbers. Also shown are the NGCU(0-9), HN(0-9), T(0-9), and U(0-9) which may be indicated on the trouble record card if the trouble record is taken during number group failure.

- (g) Trunk link frame selection is simulated by the operation of FS(0-9) key or switch in conjunction with the FG(0-2) key which indicates tens digits of the trunk link frame. On incoming calls, the FG(0-2) and TF-2/5 indicates trunk link frame used.
- (h) A particular path through the network from a line in a particular horizontal group on a line link frame to a trunk on a particular trunk link switch of a trunk link frame is defined by channel number of junctor group.
 - (1) Operation of a CH(0-9) key or CH(0-9) switch will direct the CM to select that channel number.
 - (2) Selection of a particular junctor group is not quite as straightforward. Reference should be made to the chart of SFD-D908 to select the horizontal line of the chart corresponding to the size of office. Note that the same junctor group may be selected in two or more junctor sequence positions and is dependent on junctor step position 1 or 2.
 - (3) The JSQ(0-5) key or switch should be operated to select a junctor sequence position which associates with the junctor group for the junctor step selected. In some cases, the JSQ(0-5) key or switch might be set in any of several positions to select the desired junctor group.

D9-3 USE OF CLASS OF TEST TABLES

The class of test tables shown on SFD-D910 through D915 summarizes, in tabular form, the key(s) and switch(es) used to establish the particular class of test. A single line is used to separate a particular function with its associated figure, option, key, or switch. The double line within the single lines is used to separate the various options on vintages of master test control frames. The note column and sheet notes are as follows:

- (a) Note 1 indicates that all key(s) or switch(es) must be operated to make a proper test frame setup for the particular class of test. It is suggested that known working equipment be selected for test.

- (b) Note 2 indicates that the key(s) or switch(es) to be used to simulate the trouble record. Refer to simulation tables on SFD-D902, D904, or D906 and their associated colored trouble record card on the opposite pages (D903, D905, or D907) of the simulated table selected. The tables and colored trouble record cards, along with the class of test tables, will assist the maintenance personnel in selecting the proper key(s) or switch(es) to be operated in order to properly simulate the reported trouble condition.
- (c) Note 3 indicates those key(s) or switch(es) used for additional marker tests, but they are not necessarily required for trouble record test or simulation test.

D9-4 INCOMING CLASS OF MARKER TEST (SFD-D910, D911)

On incoming class of marker test, the master test control circuit simulates an incoming trunk, incoming register, and incoming register marker connector. Through the operation of control key(s) and switch(es), the marker is primed with called number, trunk link location, and other information which it would normally receive from the incoming register.

The marker then functions in accordance with the information with which it is primed to establish a connection from the called line location to the trunk link frame on which the trunk is made to appear. Operation of the trunk link hold magnets is simulated.

The operation of the line hold magnet is simulated if the NTC key is not operated. If the NTC key is operated, the no-test hold magnet in the associated horizontal group is operated to extend the channel connection back to the master test control frame.

Once incoming class of marker test is established, other test features of the marker can be tested with various key(s) and switch(es) such as link release, reorder, double connection test, and continuity and ground tests. The PBX and EBH hunt features of PBX lines can also be performed along with PBX allotter features.

Special marker test for no-test, no-hunt, and neither no-test nor no-hunt can also be tested.

D9-5 SUBSCRIBER LINE CLASS OF TEST (SFD-D912)

The subscriber line class of test is used to set up a connection from the master test control frame voltmeter test circuit to any line to be tested. The master test control frame simulates a no-hunting incoming trunk that has an appearance on a trunk link frame and an incoming register. It extends this trunk to the master test control frame voltmeter test circuit where tests for foreign potentials, crosses, leakage, and opens are made.

After the master test control frame has seized the selected marker through the master test frame connector, the MTC provides the marker with the necessary information to set up the connection. The marker proceeds to seize the selected line and to establish a connection between the line and the simulated trunk. When the connection is established, the marker operates the line hold magnet and then releases. The connection is held under control of the MTC and the voltmeter test circuit. The test personnel can apply the necessary test on the line, which includes ringing, talking, and listening from the master test control frame telephone set.

D9-6 MARKER LINE VERIFICATION CLASS OF TEST (SFD-D913)

The MLV (marker line verification) class of test is used to verify the cross-connections in the number group and class-of-service cross-connections in the line link frame for any line and for intercept and similar trunks to which arbitrary class of service and line number have been assigned.

A complete MLV test is made in three stages

- (a) First Stage - the test circuit connects to a marker and matches the line location, tens block, terminating treatment, and ringing control information which the marker receives from the number group and class-of-service information which it receives from the line link frame against information previously set up on keys and switches. Lamps are lighted to indicate verification match or failure. If there is a match and if the TLV key had been operated at the start of the test, the test circuit recycles to stage 2.
- (b) Second Stage - consists of directing a marker to set up a connection to a sender and priming it with the line location and tip or ring party identification from the same keys which were used to verify the line location and ringing control cross-connections of the number group. When

the connection to the sender has been set up and the marker gives a release signal, the test circuit recycles to stage 3 to be ready to be connected to a transverter which the sender will have seized.

- (c) Third Stage - the transverter which was seized by the sender connects to the test circuit and to a translator to which it transmits the line location. The test circuit verifies that the line number (which the transverter receives from the translator) matches the line number being verified.

The MLV test, first stage, verifies the number group and line link crossconnects and is discussed in SCD-D9-8.1.

D9-6.1 FIRST STAGE - VERIFICATION OF LINE CROSS-CONNECTIONS IN NUMBER GROUP AND LINE LINK FRAME

The numerical digits, the line location, the ringing combination, and the office code (in terms of office A or B) of the line to be verified, are set up on keys and switches of the MTC. The test circuit, simulating a no-hunt incoming trunk and incoming register, connects to and primes a marker with the office indication and the number of the line. The marker connects to a number group to obtain the line location and then connects to the line link frame to which it is directed by the number group. The line location and ringing combination received from the number group and the class of service received from the line link frame are matched against the operated keys of the test circuit. If there is a mismatch, a MLVF (marker line verification failure) lamp is lighted and a trouble record is taken which indicates the mismatch and the actual line cross-connection. If there is a match, a MLVM (marker line verification match) lamp is lighted but a record is taken only if the REC key is operated.

D9-7 INCOMING REGISTER CLASS OF TEST (SFD-D914)

On an IR (incoming register) class of test, the MTC is used only to provide the called number and certain incoming class information which the IR normally receives from the IRL (incoming register link) circuit. The IR group key(s) or switch(es) of the AMRST (automatic monitor register sender test) circuit are operated to prepare the MTC for selection of the incoming register group and IR to be tested. Also, various key(s) for test conditions of IR and IRL, and selected speed of pulsing are operated.

The test circuit seizes the desired IR through the special test appearance at the IRL. In each IRL group, the "0" vertical of horizontal group 0 is reserved for the AMRST appearance. The test vertical appears in the IRL group in the same manner as an incoming trunk. The AMRST calls for the desired IR through the trunk preference chain in the IRL group as an incoming trunk does. When the AMRST has seized the IR, it makes preliminary tests and then pulses the called number into the IR.

After the number is pulsed and recorded in the IR, it seizes its associated IRMC and selected marker. The called number is then passed to the marker and AMRST circuit through the MTFC. The AMRST matches the received called number with the number received from the MTC frame. If they match, the OK lamp lights on test panel. Failure to match results in the TBL lamp lighting and a trouble record card is perforated.

On this type of test, the marker does not establish any connections to line link or trunk link frames.

D9-8 INCOMING TRUNK TEST - NO PULSING (ITNP) CLASS OF TEST (SFD-D915)

The ITNP test is used for testing incoming trunks in the No. 5 crossbar office. Before proceeding with the test, the trunk test circuit is patched to the incoming trunk to be tested. The MTC (master test control) frame connects to the trunk test circuit and signals it to prepare for an ITNP class of test.

The trunk test circuit closes a loop on the tip and ring leads to the incoming trunk and grounds its D lead. The trunk connects to an incoming register and extends the grounded D lead which causes the register to recognize that it is handling a test call. The register connects to a marker without waiting for a number to be pulsed and operates the TST relay in the marker as a test signal. The marker, upon receiving the test signal, connects through the master test control circuit which supplies the number of the line that must be connected to the trunk. The marker proceeds to set up a connection from the incoming trunk to the line location determined by the MTC.